CELGAR EXPANSION REVIEW PANEL
FINAL REPORT

SUBMITTED UNDER THE
FEDERAL ENVIRONMENTAL ASSESSMENT AND REVIEW PROCESS
AND
BRITISH COLUMBIA MAJOR PROJECT REVIEW PROCESS

Mrs. Jill Bodkin, Chairman
Dr. Thomas Northcote, Member
Dr. Paul Thomas, Member

February, 1991

91-03871/

CELGAR EXPANSION REVIEW PANEL

MRS. JILL BODKIN (CHAIRPERSON)
DR. TOM NORTHCOTE
DR. PAUL THOMAS

No. 12-415 West Cordova Street, Vancouver BC Canada V6B 1E5 (604) 682-7607 / 1-800-665-0929
1414 Columbia Avenue, Castlegar, BC Canada V1N 3K3 (604) 365- 7709

February, 1991

Honourable Bernard Valcourt,
Minister of Fisheries and
Oceans,
Room 1579, 200 Kent St.,
Ottawa, Ontario

Honourable Robert de Cotret,
Minister of the Environment,
Room 337, West Block,
House of Commons,
Ottawa, Ontario

Honourable Cliff Serwa,
Minister of Environment,
Room 112,
Parliament Buildings,
Victoria, B.C.

Dear Ministers,

The Celgar Expansion Review Panel has the honour of submitting this, our Final Report, under the Federal Environmental Assessment and Review Process and the British Columbia Major Project Review Process.

Mrs. Jill Bodkin
Chairman

Dr. Thomas Northcote
Member

Dr. Paul Thomas
Member

TABLE OF CONTENTS

Page

PREFACE VI

1. Hearings
2. The Panel's Approach
3. Key Considerations
4. Appreciation

RECOMMENDATIONS IX

1. Wood Chip Supply
2. Transportation
3. Pulp Mill Process
4. Water Quality and Aquatic Resources
5. Air Quality
6. Economic, Social and Community Issues

CHAPTER 1 1
INTRODUCTION

1.1 The Proposal
1.2 Terms of Reference
1.3 Interim Report
1.4 Government Announcements
1.5 Final Recommendations
1.6 Further Government Announcements

CHAPTER 2 4
REVIEW PROCESS

2.1 Prospectus Review
2.2 Stage II Report
2.3 Panel Appointment
2.4 Pre-Hearing Review
2.5 Community and Technical Hearings
2.6 The Public File

CHAPTER 3 5
WOOD CHIP SUPPLY ISSUES

3.1 Wood Chip Requirements
- 3.1.1 Sawmill Wood Chip Requirements
- 3.1.2 Round Wood Chip Requirements

3.2 Sawmill Wood Chip Availability
- 3.2.1 Sawmill Wood Chip Supply
- 3.2.2 Sawmill Wood Chip Sources

Page

3.3 Round Wood Chip Availability
- 3.3.1 Round Wood Supply
  - AAC Pulp Log Supply
  - AAC Waste Wood, Other Small Wood and Small Pine
  - Non AAC Pulp Log Supply
- 3.3.2 Round Wood Sources

3.4 Security of Wood Chip Supply
- 3.4.1 Sustainability of Wood Supply
  - Current Practices
  - Intensive Forestry
- 3.4.2 Vulnerability to Supply Disruptions and Shortfalls
  - Potential AAC Reductions
  - Potential Sawmill Production Disruptions
- 3.4.3 Increased Sawmill Recovery

3.5 Effects of Potential Additional Harvesting
- 3.5.1 Forest Management and Watershed Effects
- 3.5.2 Log Transport and Handling Effects

3.6 Hog Fuel Utilization

CHAPTER 4 15
TRANSPORTATION ISSUES

4.1 Transportation Requirements

4.2 Highway System Impacts
- 4.2.1 Traffic Volumes
- 4.2.2 Ferry Capacity
- 4.2.3 Road Capacity and Deterioration

4.3 Truck Traffic Safety
- 4.3.1 Vehicle Accident Rates
- 4.3.2 Highway Safety Issues
  - Speed Limits
  - Road Widths
  - Vehicle Spacing and Passing Lanes
  - Winter Driving Conditions

4.4 Community Traffic Concerns
- 4.4.1 Local Traffic and School Bus Operation
- 4.4.2 Pedestrians and Cyclists
- 4.4.3 Amenity and Noise Impacts
- 4.4.4 Vehicle Emissions

4.5 Highway Improvements to Mitigate Truck Traffic Impacts
- 4.5.1 Robson Bridge Proposal
- 4.5.2 Proposed Highway Upgrading
- 4.5.3 Traffic Management

Page

4.6 **Options to Avoid Truck Traffic Impacts**
- 4.6.1 Wood Chip Transportation Alternatives
- 4.6.2 Regional Transportation Plan
- 4.6.3 Road Options
- 4.6.4 Rail Options
- 4.6.5 Barge Options
- 4.6.6 Conclusions Regarding Transportation Alternatives

CHAPTER 5 31
PULP MILL PROCESS ISSUES

5.1 **Process Design**
- 5.1.1 General Description of Process Changes
- 5.1.2 Best Available Control Technology
- 5.1.3 Effectiveness in Reducing Organochlorines

5.2 **Process Operation**
- 5.2.1 Construction and Start-up Phase
- 5.2.2 Operating Capacity and Upsets
- 5.2.3 Research Program into Chlorine Elimination

5.3 **Liquid Effluent Control and Treatment**
- 5.3.1 Proposed Treatment System
- 5.3.2 Capacity of Treatment Stages
- 5.3.3 System Performance
- 5.3.4 Effluent Monitoring

5.4 **Air Emission Control and Treatment**
- 5.4.1 Emission Rates
- 5.4.2 Incineration of Total Reduced Sulphur
- 5.4.3 Incineration of Sludge
- 5.4.4 Emissions from Effluent Treatment
- 5.4.5 Emission Monitoring

5.5 **Spill Control**

5.6 **Environmental Management of Operations**

5.7 **Energy Production and Consumption**

CHAPTER 6 45
WATER QUALITY AND AQUATIC RESOURCE ISSUES

6.1 **Effluent Dispersion**
- 6.1.1 Flow Regime and Hydraulics
- 6.1.2 Mixing and Dilution
- 6.1.3 Hydroelectric Developments

6.2 **River Water Quality**
- 6.2.1 Existing Conditions
- 6.2.2 Contaminant Loadings

6.3 **Groundwater Quality**
- 6.3.1 Potential Risks
- 6.3.2 Proposed Studies

6.4 **Chlorinated Organic Compounds**
- 6.4.1 Levels of Contaminants
  - – Dioxins and Furans
  - – Chlorinated Phenolics
  - – Adsorbable Organohalogens (AOX)
- 6.4.2 Fate of Contaminants

Page

6.5 **Nutrients and Algal Growth**
- 6.5.1 Nitrogen and Phosphorus Levels
- 6.5.2 Algal Growth Potential

6.6 **Fibre Mat**
- 6.6.1 Characteristics
- 6.6.2 Remedial Actions

6.7 **Fish and Wildlife**
- 6.7.1 Fish Species and Habitat
- 6.7.2 Effects on Fish
  - - Acute Effects
  - - Sublethal Effects
- 6.7.3 Effects on Wildlife

6.8 **Recreation**
- 6.8.1 Recreational Uses
- 6.8.2 Health Advisories

6.9 **Log Transport and Handling**

6.10 **Water Quality Monitoring**
- 6.10.1 Integrated Monitoring Program
- 6.10.2 Monitoring Methods
  - - Biological Testing
  - - Effects Monitoring
- 6.10.3 Environmental Reporting and Consultation

6.11 **Enforcement and Compliance**

CHAPTER 7 63
AIR QUALITY ISSUES

7.1 **Climate and Terrain**

7.2 **Dispersion of Emissions**

7.3 **Ambient Air Quality Effects**

7.4 **Health and Safety Concerns**
- 7.4.1 Workplace Air Quality
  - - Risks of Respiratory Impairment
  - - Cancer Risk from Exposure to Dioxins and Furans
- 7.4.2 Community Air Quality

7.5 **Acid Deposition Potential**

7.6 **Vegetation and Ecosystem Impacts**

7.7 **Greenhouse Gases**

7.8 **Air Quality Monitoring**

7.9 **Enforcement and Compliance**

Page

CHAPTER 8 73
ECONOMIC, SOCIAL AND COMMUNITY ISSUES

8.1 **Community Development and Stability**
- 8.1.1 Current Impact of Celgar
- 8.1.2 Impact of the Expanded Mill
- 8.1.3 Possible Mill Closure
- 8.1.4 Impact of the Proposal on West Kootenay Communities

8.2 **Construction Phase**
- 8.2.1 Employment Impacts
- 8.2.2 Social and Community Impacts

8.3 **Infrastructure and Servicing**

8.4 **Archaeological Impacts**

CHAPTER 9 78
COMMENTS ON THE REVIEW PROCESS

9.1 **Legal Framework**

9.2 **Hearing Procedures**

9.3 **Makeup of the Panel**

9.4 **Local Involvement**

9.5 **Media Involvement**

9.6 **Educational Material**

9.7 **Timing Considerations**

9.8 **Mandate of the Panel**

9.9 **Resources**

APPENDICES 80

Appendix 1: **Celgar Review Panel Terms of Reference**

Appendix 2: **Public Reference Centres**

Appendix 3: **List of Presentations**

Appendix 4: **List of Documents and Submissions**

Appendix 5: **Panel Members and Personnel**

Appendix 6: **Glossary**

Cover Photo: *Looking upstream across Columbia River toward Celgar Pulp Mill.*

List of Tables

		PAGE
Table 1	Sawmill Wood Chip Supply in Southeast British Columbia and Washington State	8
Table 2	Sawmill Wood Chip Production and Disposition by Celgar Pulp Mill Supply Regions	9
Table 3	Pulp Wood Sources in Southeast British Columbia	11
Table 4	Current and Proposed Commodity Shipments	15
Table 5	Estimated Changes in Highway Traffic Volumes in Southeast British Columbia	18
Table 6	Effects of Additional Truck Traffic from Celgar Pulp Mill Expansion on Highways 23 and 6	19
Table 7	Summary of British Columbia Ministry of Transportation and Highways Capital and Rehabilitation Projects in the West Kootenay Region	24
Table 8	Summary of Wood Chip Transportation Options	26
Table 9	Celgar Pulp Mill Effluent Characteristics Compared to Proposed Standards	38
Table 10	Comparison of Existing and Modernized Mill Annual Emissions at Celgar Pulp Mill	41
Table 11	Comparison of Mean Daily Effluent Loadings to the Columbia River from Celgar Pulp Mill	48

List of Figures

		PAGE
Figure 1	Geographic Setting of the Celgar Pulp Mill Project in the Kootenay Region of British Columbia	2
Figure 2	Celgar Pulp Mill and Community Setting	3
Figure 3	Celgar Pulp Mill Wood Chip Supply Regions	6
Figure 4	Sawmills in the Celgar Wood Chip Supply Regions (Current and Potential Suppliers)	7
Figure 5	Sawmill Wood Chip Supply in Southeast British Columbia and Washington State	9
Figure 6	Available Pulp Wood Supply in Southeast British Columbia	10
Figure 7	Highway System and Galena Bay Ferry in the West Kootenay Region	16
Figure 8	Highways and Railways, Castlegar - Nakusp	17
Figure 9	Shelter Bay - Galena Bay Ferry Service Demand and Capacity	20
Figure 10	Proposed Robson Bridge and Brilliant Interchange Area at Castlegar	23
Figure 11	Railway Network in the West Kootenay Region	29
Figure 12	Celgar Pulp Mill Diagram of Process Flow	32
Figure 13	Organochlorines (Chlorinated Organics)	34
Figure 14	Celgar Pulp Mill Effluent Treatment System	37
Figure 15	Columbia River, Lower Arrow Lake to Canada-U.S. Border	45
Figure 16	Columbia River, Canada-U.S. Border to Roosevelt Lake	46
Figure 17	Daily Discharge of the Columbia River at the Hugh Keenleyside Dam (1970 – 1989)	47
Figure 18	Fibre Mat and Diffuser at Celgar Pulp Mill	54
Figure 19	Recommended Columbia River Integrated Monitoring Program	59
Figure 20	Castlegar Area Topography	64
A PRIMER ON DIOXINS AND FURANS		50

PREFACE

As Ministers and the public review this report, the Celgar Expansion Review Panel urge you to recognize the extraordinary contribution of all participants. They offered the Panel the most advanced of scientific research and the benefits of local knowledge. The many participants who cared about the outcome enriched our understanding of their deepest aspirations for their heritage. Thankfully, we enjoyed a frequent spirit of wonderful humour.

1. HEARINGS

The impressive range of participation made clear the importance attached to the Celgar expansion proposal by those it affected. The Panel advised participants that the hearing process was neither a referendum, nor a political town hall meeting, nor a test of ideological conviction. Rather, this Panel's review was a serious inquiry into the probable consequences of the proposed expansion of the Celgar mill on this particular area of the Kootenay region. The process seems to have inspired the best that participants had to offer, and the Panel assured them that their views would receive the most careful attention and interest.

Participants responded by offering the information the Panel needed, presented seriously, in view of the profound consequences of the proposal, no matter what their interests. In spite of the feelings of acrimony and bitterness before the beginning of the Panel's process, participants listened to each other and resisted extremes of shrillness. Everyone continued throughout the process to learn. Interested parties stretched themselves to draw on the best of resources available, to inform themselves and the Panel.

The hearings on the pulp mill process and its effects on water and air quality, more than any other subject, were marked by the quality of scientific inquiry and challenge. The Panel was honoured, fascinated and at times troubled by the representations from those at the leading edge of scientific knowledge. They contributed results of their research, not always conclusive, but always important, to the Panel's understanding of the risks to life and health associated with this particular mill, on this particular river, in this particular valley. The Panel and participants also heard their views as to ways in which those risks might be reduced.

They argued that the Panel must make judgements on the comprehensive environmental consequences of development in the region. The Panel shared their view that we must indeed examine the incremental effect of this project against a knowledgeable, comprehensive backdrop.

Participants recognized that one of the demands for wisdom on the Panel's part was the arbitration of acceptable community standards for environmental, social and economic impact in light of changing standards in law and evolving science.

Most impressive of all was the spirit of working together which developed among those who care about the quality of life and the livelihood of residents of the communities affected, despite their diverse interests. Participants gave the Panel confidence that the company and the communities of the west Kootenay region will all continue to thrive according to their values.

It will take tolerance to reconcile those values. There is passion behind the desire for the project on the part of those communities and businesses whose prosperity depends on Celgar's economic health, and their fear that Celgar's inability to meet environmental standards could lead to closure of the mill. Equally passionate is the commitment of those who have chosen a rural way of life and want to preserve the remote, natural beauty of the Slocan valley. Some found industrial development with any degree of environmental impact unacceptable. Others insisted on particular conditions which would make the project acceptable.

2. THE PANEL'S APPROACH

Scientific knowledge, although developing rapidly, is inconclusive in many areas of importance to the Panel's consideration. The Panel's approach has been to take predicted risks seriously, particularly where there is potential damage to living creatures involved. Where scientists presented indications of possible serious harm, not yet conclusively proven, the Panel's recommendations attempt to avoid such risks. For instance, science is finding new indications of sublethal effects of dioxins and furans in fish, which increases the risk of adverse effects which may concentrate up the food chain. The Panel believes it is preferable to work towards a goal of total elimination of elemental chlorine, the main source of dioxins and furans in pulp mill effluent, rather than expending effort in improving detectability in water.

The Panel has been persuaded by predictions of adverse consequences on the basis of conditions as close to reality as possible, as we have been skeptical of predictions based on abstract models whose parameters may underestimate, overestimate or even not consider known conditions. For example, the ambient air effects model chosen by the provincial Ministry of Environment imposed costs and effort on the proponent and other participants which could more

Celgar Expansion Review Panel: Dr. Tom Northcote, Mrs. Jill Bodkin, Dr. Paul Thomas.

productively have been focused on developing measures which would control the impact of air emissions during calm conditions and temperature inversions, a not unusual feature of Castlegar's weather pattern.

Where harmful environmental effects were possible, but of uncertain likelihood, the Panel's approach has been to require careful measurement of the actual experience, and remedial action if a problem materializes, rather than to impose further costs to control problems which might not exist. For example, the Panel recommends that the design of the effluent treatment system accommodate future space for a short anaerobic stage, in case chlorate is found to be a problem. Faced with some uncertainty about the risk of attached algal growth on the river bottom, the Panel's recommendation is for in-river studies of such growths, combined with experiments to test the effect of Celgar's nutrient loadings on a simulated river environment as close to the mill as possible.

The Panel believes that the proponent should bear the cost of prediction and mitigation of direct environmental consequences, but that there is also a need to mobilize the scientific resources of governments to study and improve the general receiving environment.

3. Key Considerations

As noted in its Interim Report, the Panel found the proposal acceptable in principle, subject to measures to manage traffic and highway improvements. The Panel's further detailed conclusions and recommendations appear in the body of this report.

Pivotal considerations in the Panel's recommendation for approval were:

- the manageability of environmental impacts of the modernized mill on air and water quality, through the adoption and performance of best available control technology incorporated in the design of the mill, and the company's commitment to monitoring environmental effects and solving problems;[1]
- the scientific judgement that current accumulations of organochlorines, particularly dioxins and furans, in fish and other living organisms in the Columbia River valley, could be reduced over the long term by Celgar's modernization;
- the commitments of Celgar, Cominco, B.C. Hydro, and the British Columbia government to an integrated monitoring program, with the potential involvement of the Canadian government and United States federal and state agencies;
- the substantial decreases in total reduced sulphur

1. The proposed mill is predicted to discharge lower levels of pollutants than those required by the proposed standards of the federal and provincial governments at the time of the Panel's hearings, in particular the objective of 1.5 kg of adsorbable organic halogens (AOX) per air dried tonne of pulp.

emissions, with the resulting sharp reduction of typical pulp mill odour;

- the 90% energy self-sufficiency of the proposed mill;
- the need to reduce Celgar's continued pollution levels, with the current mill allowed to exceed even today's government standards;
- the likely closure of Celgar, if modernization does not proceed, with severe consequences to the communities and to those whose livelihood depends on Celgar, as well as the area's sawmilling, transportation and forestry operations;
- the availability of transportation alternatives to avoid trucking of wood chips through the Slocan valley, with possible total public and private costs comparable to the costs of highway and traffic improvement measures which otherwise are necessary to mitigate the transportation impact of the project;
- the substantial margin of wood chips and pulp logs available, beyond the projected requirement to support Celgar's expansion, and the opportunity to process them into pulp in the region rather than to export or waste chips.

However, strict measures for environmental control must be applied. Although Celgar has demonstrated a substantial future commitment, the past performance of its admittedly outdated mill gives little comfort to segments of the community. Achievement of acceptable conditions for the environment, for the people who live in the surrounding communities, and for those who work in the mill, will require that the company assume genuine responsibility for minimizing adverse consequences of its operation. The Panel was impressed by the dedication of residents, workers and other industrial users of the Columbia River, to cooperate with Celgar on environmental improvement. The Panel expects individual and organizational demonstration of Celgar's commitment to monitoring and problem solving. The expectation of environmental protection must permeate policies and practices of the company, its owners, management and all staff, whose activities could affect pollution from the mill.

4. Appreciation

The work of the Panel depended on the fine support of its administrative, technical and legal staff.

Alan Ferguson, the Panel's Executive Secretary, forged our link with all interested parties. His organizational competence and sensitivity to participants' needs paved the way for the tone of our hearings and for us to thoroughly canvass the issues. Our deliberations were enriched by his analytical abilities. His choice and inspiration of support personnel, including the willing and able people who supported our work in the communities of the west Kootenays, made possible the long hours of hearings as our caravan progressed, and production of public material under tight deadlines.

The Panel's counsel, Frank Borowicz, ensured the integrity of the Panel's review, through advice on the design of our procedures, negotiation with counsel for participants of appropriate representation to inform the Panel's conclusion, and a constant attitude of problem solving around the complex issues of evolving law which surrounds independent environmental assessments.

Participants and the Panel benefitted from the technical advice of Ken Hall (Aquatic Ecology), Ron Kistritz (Aquatic Ecology), Don McLeay (Water Quality), Jim McWilliams (Forestry), Frank Murray (Air Quality), Bob Partington (Transportation) and Paul Roer (Transportation). The depth of their knowledge and their creative approach to seeking solutions added perspective to all interested parties' review of Celgar's proposal.

The Panel wishes to thank all participants for their representation. The proponent's willingness to provide technical information and experts strengthened the Panel's review and the communities' understanding, particularly with regard to recent advances in pulp mill environmental control technology. Similarly, our review was enhanced by knowledge made available by the sponsoring governments, who offered a blend of hands-on experience in the west Kootenay environment with comprehensive results of scientific research. We appreciated the contribution of organizations like the Kootenay Coalition for an EARP and Local No. 1 of the Pulp Paper and Woodworkers of Canada in bringing forward analysis necessary to inform our work.

A special note of thanks is due to the people of the west Kootenays, whose intense interest in our proceedings was rewarding. The dedicated attention of the local press to the Panel's hearings ensured that these communities were well informed of issues of great importance to them.

The Panel hopes that Ministers join us in thanking all who contributed to our work. The responsibility for our recommendations, of course, rests with the Celgar Expansion Review Panel alone. It has been an honour to conduct this review of the proposed Celgar modernization, and its consequences for the quality of life in the surrounding communities.

RECOMMENDATIONS

1. WOOD CHIP SUPPLY

Recommendation 1

Although management of provincial Crown forests was excluded from the Panel's mandate, the Panel recognizes that there may be governmental decisions regarding harvesting which pertain to the supply of wood chips for Celgar and which have undesirable environmental effects. Such decisions may include approval of forest management plans and permits under existing tenures, rights to additional harvesting under Pulpwood Agreement No. 9, and changes to forest management resulting from the work of the Forest Resources Commission. The Panel recommends that any decisions take into consideration the protection of high elevation forests, community watersheds, fish and wildlife habitat, soil quality and recreational and aesthetic use of the forests in southeastern British Columbia.

Recommendation 2

The Panel specifically recommends to the Forest Resources Commission that it consider initiating a comprehensive program of local resource use plans in southeastern British Columbia, including:

- identifying designated areas for new and revised local resource use plans;
- establishing detailed planning procedures which explicitly incorporate industry and public objectives for integrated and sustainable forest management and ecosystem variables which may have been overlooked in the past;
- providing public involvement in the selection of land use options and forest management practices;
- preparing a program and schedule for undertaking these plans; and
- preparing an annual report on the progress and results of this program.

Recommendation 3

The Panel recommends that the provincial Ministry of Energy, Mines and Petroleum Resources and Ministry of Environment undertake an evaluation of options for the use or disposal of hog fuel from Westar's sawmill made surplus by the proposed Celgar modernization, and the opportunities for energy production from this resource.

2. TRANSPORTATION

Recommendation 4

The Panel recommends that additional capacity on the Galena Bay Ferry be provided to accommodate projected growth, as well as additional demand for ferry transportation of chip trucks resulting from Celgar's proposal.

Recommendation 5

The Panel recommends that traffic safety measures on Highways 6 and 23 be introduced:

- to control the movement of trucks so as to avoid their arrival and departure from the Galena Bay Ferry in convoy;
- to reduce the speed limit for all vehicles from the current 90 kph; and
- to restrict the traffic of heavy trucks during hours when school buses pick up and deliver children.

Recommendation 6

The Panel recommends that the British Columbia Ministry of Transportation and Highways and the Regional District of Central Kootenay develop a transportation plan for the Slocan valley.

Recommendation 7

The Panel's attention was focused on the impact of truck transportation as proposed by Celgar, and the provincial government has made a public commitment to accept the Panel's recommendation for road transportation improvements. In parallel, the Panel also recommends, as a follow-up to the 1989 Kootenay Region Transportation Task Force Report, that alternatives to avoid the impact and costs associated with mitigation of increased trucking of wood chips on Highway 6 and 23 be considered by a task force, which would undertake a study of the public and private costs and benefits of barge, rail, and private and public road alternatives in comparison with the truck transportation alternative proposed by Celgar.

3. PULP MILL PROCESS

Recommendation 8

The Panel recommends that the pulp mill process technology proposed by Celgar be approved, since it accords with the best available control technology for minimizing adverse environmental effects for the type of pulp to be produced, and it exceeds the most stringent standards described by the federal and provincial governments during the Panel's public hearings.

Note: These recommendations appear in the text in the same order as this list. They are identical to the recommendations submitted to governments on January 28, 1991, although the sequence and numbering is different.

Recommendation 9

The Panel recommends that the environmental standards for the mill be based on the performance achievable under best available control technology as proposed by Celgar.

Recommendation 10

The Panel recommends that the effluent treatment system be constructed, if possible, during the initial phases of the three year construction program, thereby the effluent streams in the existing mill would receive secondary treatment, in accordance with a schedule to be approved by the British Columbia Ministry of Environment.

Recommendation 11

The Panel recommends that, in order to minimize the formation of chlorinated organics, especially dioxins and furans, during the construction period of the expanded mill, Celgar be required:

(a) to investigate and test the use of peroxide with either single or multi-point addition;

(b) to assess cooking and bleaching conditions; and

(c) to continue its research into fluctuating furan levels in the pulp, and if possible, to use the results to reduce the levels.

Recommendation 12

The Panel recommends that Celgar be required to demonstrate that it is sponsoring or carrying out research to reduce elemental chlorine usage. The research should include investigation of potential ozone usage. An annual report on the research program should be submitted to the British Columbia Ministry of Environment.

Recommendation 13

The Panel recommends that the effluent treatment system be designed to accommodate the future addition of tertiary treatment, as well as a short anaerobic stage of treatment, if monitoring indicates that these are required to achieve predicted discharge qualities (see Recommendations 27 and 30).

Recommendation 14

The Panel recommends that, in the final detailed design of the effluent treatment system, the size of the cooling equalization pond be checked to determine if any expansion is required.

Recommendation 15

The Panel recommends that Celgar be required to establish a routine effluent monitoring program, which incorporates appropriate chemical and a carefully selected array of biological tests by qualified environmental technicians at all stages of effluent treatment; and that the results of those tests be cued to specific process management responses to control the quality of any discharges.

Recommendation 16

The Panel recommends that manual backup monitoring be established to support and supplement automated effluent and emission monitoring and alarms.

Recommendation 17

The Panel recommends that Celgar be required to evaluate the incineration of total reduced sulphur in the power boiler as a means of reducing SO_2 emissions.

Recommendation 18

The Panel recommends that the federal and provincial governments undertake their planned controlled test burn of an effluent sludge, comparable to the sludge of Celgar's proposal, as soon as practicable.

Recommendation 19

The Panel recommends that Celgar be required to make provision for later adoption of sludge incineration, if test results are found to be satisfactory.

Recommendation 20

The Panel recommends that Celgar be required to monitor air emissions from the stacks, with alarm and reporting procedures when air emission standards are exceeded.

Recommendation 21

The Panel recommends that Celgar be required to prepare a spill control and response plan, in consultation with government agencies, mill workers, and community groups; to provide staff training; and to issue public reports on incidents and responses.

Recommendation 22

The Panel recommends that Celgar be required to establish a fully equipped environmental laboratory, with the capability to undertake regular monitoring of effluents and emissions, including measurement of toxicity; and that the laboratory be staffed with qualified technicians responsible for the environmental monitoring program.

Recommendation 23

The Panel recommends that Celgar be required to assign a qualified senior level environmental manager at the mill, responsible for ensuring the implementation of Celgar's policies and practices for minimizing adverse environmental consequences of its operations.

Recommendation 24

The Panel recommends that Celgar be required to issue every six months environmental reports designed for the public, documenting the monitoring data, spill occurrence and other aspects of environmental performance at the mill (see also Recommendation 47).

4. Water Quality and Aquatic Resources

Recommendation 25

The Panel recommends that biotreatment ponds and spill ponds be required to have linings which will prevent the contamination of groundwater.

Recommendation 26

The Panel recommends that the federal Department of Fisheries and Oceans research program into water quality, fish and aquatic resources in the Fraser, Thompson and other rivers be extended in the Columbia River.

Recommendation 27

The Panel recommends that if chlorate is found to pose a water quality problem, the effluent treatment system be modified by a short anaerobic stage (see Recommendation 14).

Recommendation 28

The Panel recommends that the Integrated Monitoring Program include monitoring of attached algae (species composition, biomass, seasonal growth rate), for at least two years prior to and after full-scale operation of the pulp mill expansion, at various sites in the Columbia River, including one upstream and downstream of Celgar and one below Trail.

Recommendation 29

The Panel recommends that Celgar be required to undertake an experimental study in replicated riverside troughs to determine:

- which dissolved nutrient (nitrogen or phosphorus) is limiting attached algal biomass and production over the growth seasons evident in the natural system; and
- the effects of selected pulp mill effluent loadings on attached algal biomass and production over the growth seasons, using an appropriate control series.

Recommendation 30

The Panel recommends that the results of in-river monitoring and of trough experiments be used to establish nutrient loading levels for pulp mill effluent (and construction camp effluent, see Recommendation 49) so as to minimize undesirable algae and other aquatic vegetation growth in the receiving waters.

Recommendation 31

The Panel recommends that Celgar be required to undertake ongoing monitoring and reporting of the extent and toxicity of the fibre mat, as well as chlorinated organics within interstitial waters, sediment and bottom-dwelling invertebrates, so as to determine the degree of natural degradation and recovery after project construction, and whether remedial action is required.

Recommendation 32

The Panel recommends that the Canadian Wildlife Service undertake studies of the accumulation of contaminants, including chlorinated organics, in selected species of migratory birds in the area affected by the mill.

Recommendation 33

The Panel recommends that the Canadian and United States agencies undertake coordinated studies of the accumulation of contaminants, including chlorinated organics, in amphibians and aquatic mammals in the area affected by the mill.

Recommendation 34

The Panel recommends that Celgar and the federal and provincial governments jointly develop log storage and handling procedures for minimizing the deposition of wood debris and fibre into the aquatic environment.

Recommendation 35

The Panel recommends that the federal Department of the Environment, including the Canadian Wildlife Service, and the Department of Fisheries and Oceans, become direct participants in the Integrated Monitoring Program.

Recommendation 36

The Panel recommends that the federal and provincial governments take measures to secure the participation of the U.S. Environmental Protection Agency and the Washington State Department of Ecology in the Integrated Monitoring Program.

Recommendation 37

The Panel recommends that the final design of the Integrated Monitoring Program include only those physical, chemical and biological indicators which will have a high probability of detecting change, and which can be used to prescribe action to manage and abate adverse consequences.

Recommendation 38

The Panel recommends that the Integrated Monitoring Program require an annual report summarizing the results and informing the public of environmental conditions and trends in the Columbia River system.

5. Air Quality

Recommendation 39

The Panel recommends that regular maintenance shutdowns of the lime kiln be timed to avoid adverse weather conditions and so minimize ambient SO_2 concentrations (See also Recommendation 17).

Recommendation 40

The Panel recommends that Celgar be required to demonstrate measures to minimize the risk of exposure of residents of the construction camp to hazardous gases and chemicals.

Recommendation 41

The Panel recommends that the British Columbia Ministry of Health, Workers' Compensation Board and Cancer Control Agency studies of health risks to pulp mill workers in British Columbia include Celgar as a survey site, and make recommendations for control of workplace exposure to hazardous substances, and risk of respiratory disease.

Recommendation 42

The Panel recommends that Celgar involve the Pulp, Paper and Woodworkers Union, Local No. 1 in the design and implementation of measures to improve air quality in the workplace, and of measures to alert workers to the vigilance necessary to avoid or react to accidental discharges and emissions.

Recommendation 43

The Panel recommends that the British Columbia Ministry of Environment establish an acid deposition monitoring station in the vicinity of Castlegar.

Recommendation 44

The Panel recommends that the federal and British Columbia governments apply air emission standards which will protect vegetation, and aquatic and terrestrial ecosystems from significant injury, and that Celgar be required to measure environmental effects of the mill on air quality and vegetation.

Recommendation 45

The Panel recommends that the federal and provincial governments establish impact assessment and control guidelines in conjunction with their international endeavours regarding greenhouse gases, and that Celgar be required to comply, should emissions from the mill be found to exceed the guidelines.

Recommendation 46

The Panel recommends that Celgar be required to include in its air monitoring program a mobile unit, and also two additional continuous monitoring stations linked electronically to the plant control room and local offices of the Ministry of Environment.

6. Economic, Social and Community Issues

Recommendation 47

The Panel recommends that a "Columbia River Advisory Group", consisting of representatives of Celgar and responsible representatives of all communities affected by the mill, be established to review reports of Celgar's monitoring program, the Integrated Monitoring Program, and any related research from the Department of Fisheries and Oceans, the Canadian Wildlife Service, the British Columbia Ministry of Environment, and other bodies, and that this group advise Celgar and permitting authorities regarding further improvements to the environmental effects of the mill.

Recommendation 48

The Panel recommends that a community liaison committee, comprised of representatives of local government and social service agencies, be established to improve communication among Celgar, contractors, government agencies, emergency services and the public, and to monitor and respond to community impact of the construction phase.

Recommendation 49

The Panel recommends that Celgar, in connection with the construction camp, be required to predict the effect of its sewage and waste water effluent on nutrient loading to the river, taking into account in-river attached algae tests (See also Recommendation 28), and that appropriate waste treatment be required to minimize undesirable attached algae and other aquatic vegetation growth in the receiving waters.

Recommendation 50

The Panel recommends that site specific archaeological monitoring of excavations be undertaken in consultation with provincial government archaeologists.

CHAPTER 1: INTRODUCTION

1.1 THE PROPOSAL

Celgar Pulp Company is proposing to expand its bleached kraft pulp mill on the Columbia River, at Castlegar, British Columbia (Figure 1). The company operates as a joint venture between CITIC, B.C. Inc. and Power Consolidated (China) Pulp Inc.

The existing Celgar mill was constructed in 1960. The previous owners operated the pulp mill in conjunction with the adjacent sawmill and also held tenure to Tree Farm Licence No. 23 in the Lower Arrow Lakes area. In 1986, Westar Timber Ltd., which had acquired the pulp mill from Canadian Cellulose Ltd., sold the mill but maintained the sawmill and woods operations.

The mill is located on the Columbia River, 3 km west of the City of Castlegar (Figure 2). It produces approximately 560 air-dried tonnes (ADt) per day of high quality bleached kraft pulp. The proposed project would expand this production to 1,200 ADt per day, or 420,000 ADt annually. The estimated cost of expansion is over $650 million.

The company proposes to introduce best available environmental control technology which will reduce discharges of most of the harmful substances into the air and water from current levels, on an absolute basis. The company has stated that all of its wood fibre requirements can be met through purchase of surplus wood chips from sawmills and from pulp logs not now used in the area. It is proposed to transport wood chips by truck from much of the southeast region of the province and northern Washington State.

The existing mill, built some thirty years ago, operates on a variance order which permits discharges beyond government standards. Celgar Pulp Company proposes to construct the new mill over a three year period of operation, without curtailing production of the existing mill.

1.2 TERMS OF REFERENCE

The Celgar Expansion Review Panel was appointed in late June, 1990 to conduct an independent public review of the environmental and associated social effects of the proposed Celgar Pulp Mill Expansion Project, including any effects that are external to Canadian territory. The Panel's Terms of Reference are included in Appendix 1. The Panel was specifically requested to focus its review on:

- the protection of ambient air and water quality, including fish and fish habitat;
- the availability of surplus wood chips; and
- the impact of additional truck traffic resulting from the transportation of additional wood chips to the mill.

The Panel was instructed:

- to conduct public hearings in Castlegar and one or more neighbouring communities;
- to review the Company's Stage II submission and Prospectus documents and any other written material it deemed relevant;
- to provide for public access to all information provided to or prepared by it; and
- to prepare a written report to the provincial Minister of Environment, the federal Minister of the Environment and the federal Minister of Fisheries and Oceans with its recommendations, including those on the environmental acceptability of the proposed pulp mill expansion.

The Terms of Reference also stated:

> If the Panel concludes that the proposal is acceptable, it shall explain the basis for that conclusion and recommend terms and conditions under which the expansion could proceed. If the Panel concludes that the proposal is unacceptable, it shall similarly explain the basis for this conclusion.

1.3 INTERIM REPORT

The Panel's Terms of Reference indicated that, at its discretion, the Panel could prepare a short interim report soon after the completion of the public hearings, with recommendations on whether or not approval in principle for the project should be granted. On December 3, 1990, the Panel submitted an Interim Report to the British Columbia Minister of Environment, the Federal Minister of the Environment, and the Federal Minister of Fisheries and Oceans.

The purpose of the Interim Report was to inform ministers and the public of the review process to date, and to remove the uncertainty surrounding the proposal which, for some time, had faced the communities that would be affected by its rejection or acceptance.

The Panel evaluated the major issues which bear upon the overall environmental and social acceptability of the project. This included consideration of the opportunity to avoid, mitigate or manage adverse impacts of the project, and the acceptability of unavoidable impacts, risks or uncertainties associated with the project. The Panel concluded that Celgar's proposal would be acceptable with measures to mitigate transportation impacts. The Panel recommended that federal and provincial governments grant approval in principle to the project.

A summary of representation made in both the Community and Technical Hearings and the major concerns and issues discussed were included in the Report. The Report also indicated certain items which would be subject to recommendations in the Final Report.

1.4 GOVERNMENT ANNOUNCEMENTS

Following submission of the Panel's Interim Report to the federal and provincial governments, the British Columbia Minister of Regional and Economic Development, the Minister of Environment, the Minister of Provincial Secretary and the Nelson-Creston MLA jointly announced approval in principle of Celgar's pulp mill expansion project on December 20, 1990.

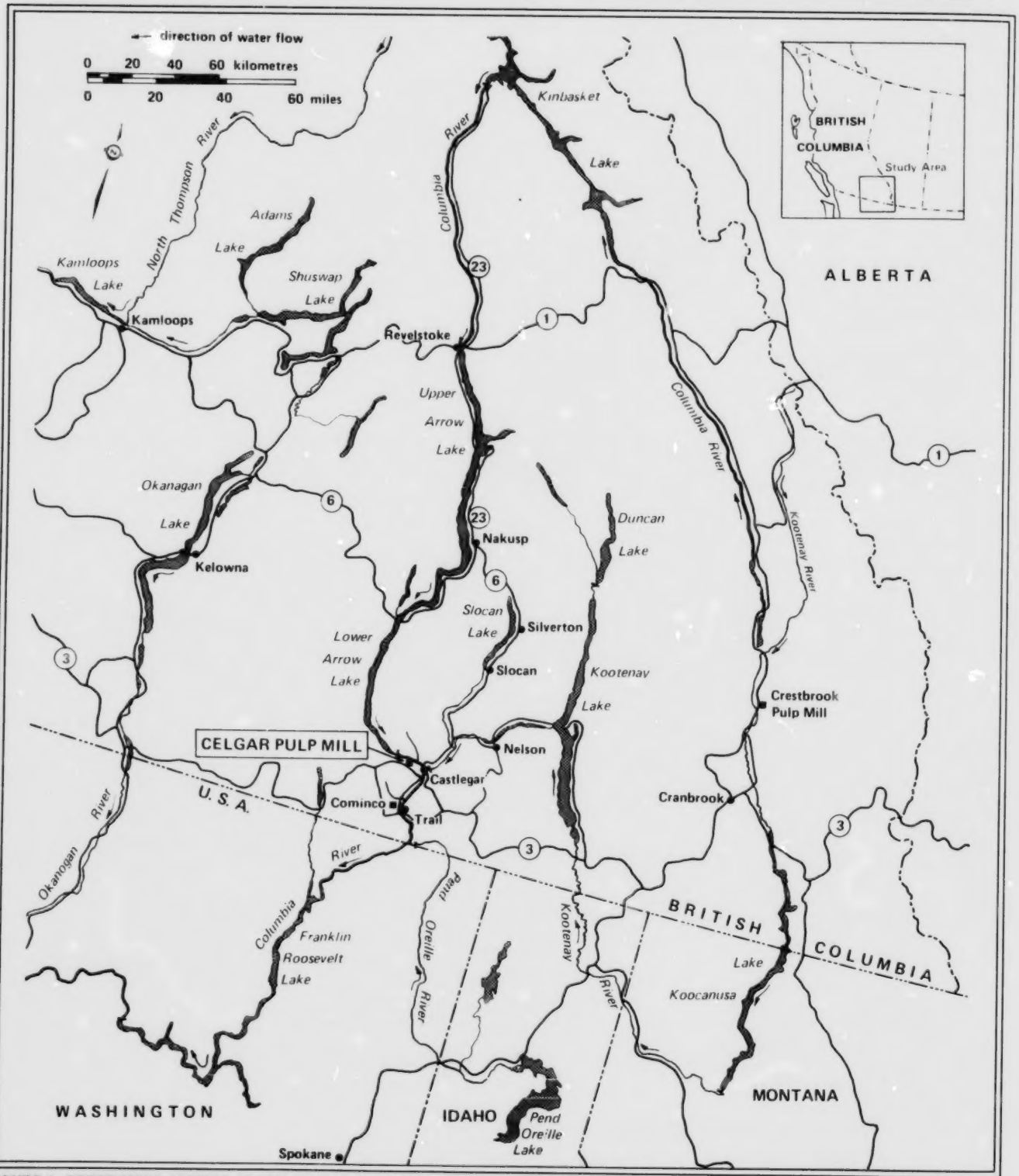


FIGURE 1. GEOGRAPHIC SETTING OF THE CELGAR PULP MILL PROJECT IN THE KOOTENAY REGION OF BRITISH COLUMBIA.

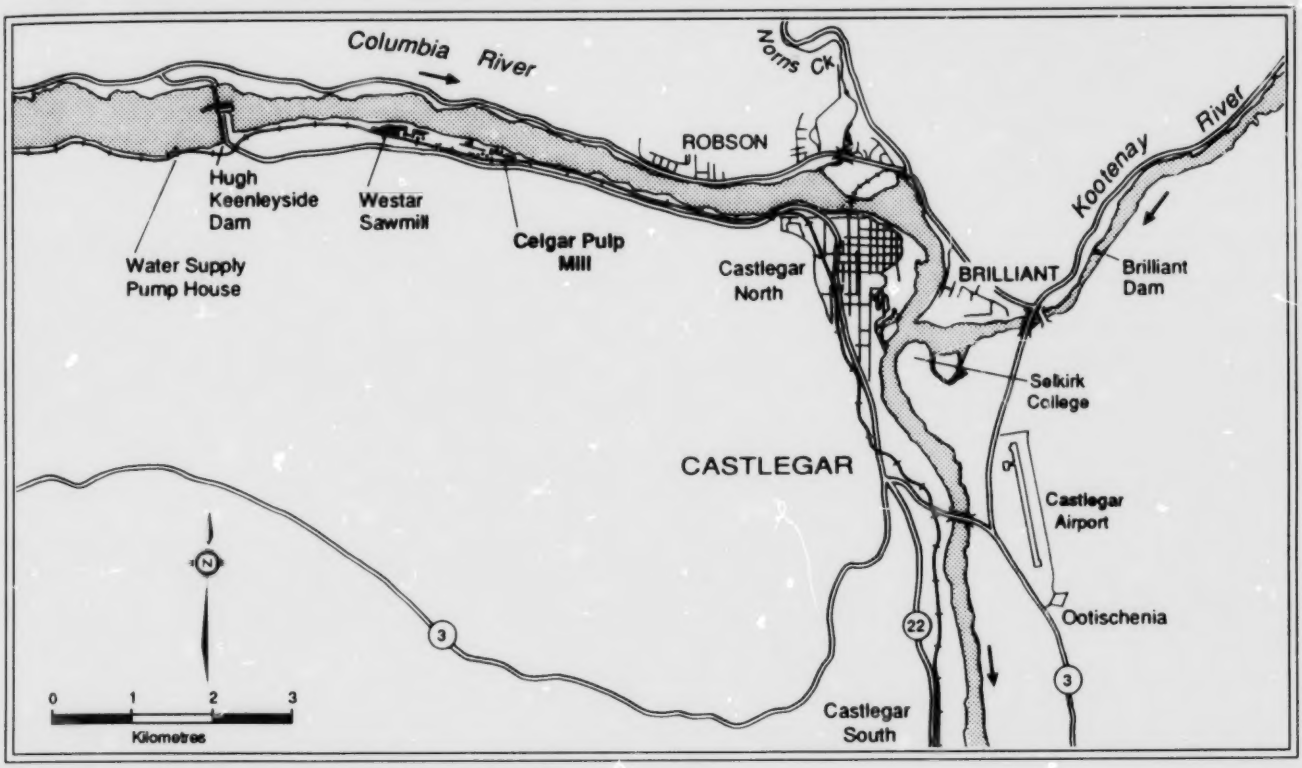


FIGURE 2. CELGAR PULP MILL AND COMMUNITY SETTING.

The approval was based on the Panel's conclusion that the proposed mill will not only meet or exceed the minimum environmental standards of the federal and provincial governments, but also that the anticipated performance of the proposed best available control technology is achievable. The approval was also based on the Panel's conclusion that feasible and effective means of managing all potentially significant environmental and social impacts of the project were available.

The provincial government indicated that the approval was subject to Celgar meeting three minimum requirements:

- the company must meet the specifications for mill design, operation procedures, contingency handling and emission and effluent levels recommended by the federal and provincial regulatory agencies;
- it must establish the monitoring and assessment programs recommended to the Panel by federal and provincial regulatory agencies;
- it must correct unanticipated and undesirable conditions found through monitoring, and satisfy the requirements of the Fisheries Act and the British Columbia Waste Management Act.[1]

The provincial government also announced its commitment to the requisite highway improvements, thus removing the Panel's qualification to the approval in principle.

1.5 Final Recommendations

On January 28, 1991, the Panel submitted its Final Recommendations to the federal and provincial governments. On the basis of the analysis of the representation, and the conclusions derived from this analysis, the Panel formulated fifty recommendations.

1.6 Further Government Announcements

On February 5, 1991, the federal Environment Minister Robert de Cotret, federal Fisheries and Oceans Minister Bernard Valcourt, British Columbia Environment Minister Cliff Serwa and Provincial Secretary Howard Dirks released the Panel's Final Recommendations.

They announced that:

> Recommendations directed to the company have now been reviewed by the Ministers. They have concluded that meeting these recommendations, together with some additional conditions they have specified, will enable the project to proceed.[2]

1. News Release, Ministry of Regional and Economic Development, "Celgar Granted Approval in Principle for Pulp Mill Expansion", December 20, 1990.
2. News Release, Government of Canada/Government of British Columbia, "Federal and Provincial Governments Release Final Recommendations of the Celgar Expansion Review Panel," February 5, 1991.

CHAPTER 2: REVIEW PROCESS

2.1 PROSPECTUS REVIEW

In compliance with the Major Project Review Process (MPRP) of the Province of British Columbia, the company filed an environmental impact assessment report as a Prospectus in December 1989. In January 1990, Celgar also submitted a socio-economic report to federal and provincial government agencies, local governments, public interest groups and public libraries in the west Kootenays, and government agencies and interest groups in the State of Washington.

2.2 STAGE II REPORT

After the completion of the initial assessment phase of the Provincial Major Project Review Process, the federal and provincial Major Project Steering Committee requested a Stage II Report from the company in accordance with the terms of reference issued by the Committee. The Stage II Report was submitted to governments and the Panel, and was made public, in July, 1990.

2.3 PANEL APPOINTMENT

The federal and provincial governments jointly appointed the Panel to conduct an independent public review of the environmental and associated socio-economic effects of the proposed pulp mill expansion. The Panel was appointed pursuant to the British Columbia Major Project Review Process, and the Federal Environmental Assessment and Review Process (EARP) Guidelines Order. The Panel members and their Terms of Reference (Appendix 1) were announced on June 28, 1989.

2.4 PRE-HEARING REVIEW

Prior to the commencement of public hearings, the Panel invited comments on the Stage II Report from interested persons and organizations, including the federal and provincial governments, and various governmental agencies in the United States. The Panel also requested specific information from the federal and provincial government agencies and from Celgar Pulp Company in order to provide an adequate information base for discussion at the public hearings.

Existing project documentation, including the Prospectus and the Stage II Report of the proponent were reviewed. This included 341 public letters submitted to the Major Project Steering Committee, prior to appointment of the Panel. The Panel also reviewed the written comments of the federal and provincial government agencies, local governments and the public on the Stage II Report.

The commencement of the public review period was advertised in Castlegar, Nelson and Trail, British Columbia and Colville, Washington, U.S.A. In order to assist public involvement, the Panel maintained a public file of all documents and correspondence at their offices in Castlegar and Vancouver and operated toll-free phone service in British Columbia and Washington State. The Stage II Report and other key documents were made available for public review at 16 public reference centres (Appendix 2). Notices were issued in newspapers, and through radio announcements, newsletters, and press releases, advising the public of the review period, the location of documents and the times and locations of the hearings. A public mailing list with some 450 names was prepared and five newsletters were distributed in July, August, September and October, 1990.

The Panel also requested independent consultants to review the Stage II document. The comments of these consultants were their own and were placed on the public record. These consultants were made available to assist participants in their review of the proposal. The consultants held four meetings with various public groups in Castlegar and Trail.

2.5 COMMUNITY AND TECHNICAL HEARINGS

As part of the public review of the company's proposal, the Panel conducted public hearings which consisted of two segments: Community Hearings and Technical Hearings. The purpose of the hearings was to undertake a full public review and examination of all the information received by the Panel, and to solicit public opinion on matters relevant to the Panel's mandate.

A pre-hearing organizational meeting was held by Panel staff in Castlegar to discuss the proposed hearings with the proponent and the public.

The Panel held Community Hearings at Castlegar, Nelson, Slocan, Silverton, Nakusp and Trail. The Community Hearings were held from September 20 through September 26, 1990. There were 176 presentations made to the Panel (Appendix 3).

Technical Hearings were held in Castlegar, from October 18, 1990 to November 1, 1990. There were 61 presentations made to the Panel at these hearings (Appendix 3).

The Panel also invited participants to submit final concluding statements or supplementary presentations following the Technical Hearings.

2.6 THE PUBLIC FILE

The Panel received over 600 written submissions (Appendix 4). This included more than 300 written submissions from the public, along with other technical material placed on the public file. There were also 58 documents submitted to the public file by government agencies, 35 documents submitted for or on behalf of the Panel, and 35 documents submitted by Celgar. At the Community Hearings, 61 documents were submitted, while at the Technical Hearings, 115 documents were submitted.

At the conclusion of the Panel's work, the full contents of the public file, including transcripts of the hearings, will be transmitted to the provincial Ministry of Regional and Economic Development in Victoria and the Federal Environmental Assessment and Review Office in Vancouver, to be maintained for the public record.

CHAPTER 3: WOOD CHIP SUPPLY ISSUES

3.1 WOOD CHIP REQUIREMENTS

3.1.1 Sawmill Wood Chip Requirements

The current Celgar pulp mill uses about 1.1 million cubic meters (m^3) of wood chips annually. The entire volume is purchased from sawmills as a byproduct of their operations. These sawmills are located in seven supply regions (Figure 3).

In 1989, 68% of the chip supply of the current mill was purchased from three sawmill operators (Westar, Slocan, and Pope and Talbot). Total chip supply originated from 17 sawmill sources (Figure 4). Celgar accounts for 17% of the consumption of total wood chip production in the southeast interior of British Columbia.[1]

The proposed mill would require 2.2 million m^3 of sawmill chips. The company expects to have a minimum of 60% of its fibre requirements under long term contract with suppliers. The following geographic sources of sawmill chips were identified in the Stage II Report:

Region 1		
Salmon Arm	441,800 m^3	20.0%
Region 2		
East Kootenays	87,000 m^3	4.0%
Region 3		
West Kootenays	857,400 m^3	39.0%
Region 4		
Washington State	176,700 m^3	8.0%
Region 5		
Boundary - Grand Forks	294,200 m^3	13.4%
Region 6		
Okanagan	342,900 m^3	15.6%
Region 7		
Kamloops	0	0%
Total	**2,200,000 m^3**	**100.0%**

3.1.2 Round Wood Chip Requirements

The current pulp mill does not chip round wood sources, although it did so up until 1988. The proposal for the expanded mill is to reactivate the woodroom and to chip whole logs at the pulp mill. Celgar proposes to chip 267,000 m^3 of logs to produce 240,000 m^3 of wood chips annually. In the "Additional Information" report submitted by Celgar, it was stated that the woodroom is capable of processing in excess of 500,000 m^3 of chips annually.

3.2 SAWMILL WOOD CHIP AVAILABILITY

3.2.1 Sawmill Wood Chip Supply

Considerable data were presented on the availability of byproduct wood chips from sawmills between 1987-1989. Five sets of data were identified during the review process. Table 1 summarizes these data for the Celgar supply region and for southeast British Columbia and northeast Washington State. Figure 3 shows the boundaries of the Celgar wood chip supply catchment area and the proposed Pulpwood Area No. 9.

Table 1 indicates that total sawmill chip production from interior British Columbia sawmills has ranged from about 5.5 - 6.5 million m^3 annually between 1987 and 1989. This includes chips derived from the processing of sawlogs within the Crown land Annual Allowable Cut (AAC) and private land sawlog supply. Current consumption from the Weyerhaeuser, Crestbrook and Celgar pulp mills is in the range of 3.66 - 3.76 million m^3 annually, while their estimated capacity is 4.01 m^3 annually. This leaves an estimated surplus ranging from 1.56 - 2.75 million m^3 of sawmill wood chips. An additional 0.11 million m^3 of sawmill chips are estimated to be surplus in northeastern Washington State.

The data on Table 1 show a significant increase in sawmill chips between 1987 and 1989. This is directly linked to sawlog harvest levels which rose from 13.5 million m^3 to 14.4 million m^3 annually.[2] No historical data were available on sawmill chip supplies. However, a general indication of the variability of wood chip supplies for the period 1980 to 1989 can be obtained from data on lumber production in the interior of British Columbia. During this period, lumber production averaged 9,320 million board feet (mbf), ranging from a high of 11,214 mbf in 1987 to a low of 6,939 mbf in 1982, a variation of 20 - 25%. It should be noted that available data on the production of wood chips in southeast British Columbia (1987-1989) correspond to a period of relatively high lumber production, with a three-year average of 11,100 mbf.

The total volume of sawmill chips potentially available to supply the required additional 1.1 million m^3 of wood chips, is estimated in the range of 1.67 - 2.86 million m^3, depending on production and consumption estimates. The proposed requirement would account for 38 - 65% of the estimated surplus of sawmill wood chips not utilized in the region during this period of record.

Figure 5 summarizes the proposed sawmill wood chip supply sources based on 1989 data. Celgar proposes to use 992,000 m^3 or 40.5% of the 2.45 million m^3 of surplus wood chips in the interior British Columbia wood chip supply regions. They also proposed to use 109,173 m^3 or 100% of the surplus wood chips in northeastern Washington State and to acquire another 67,500 m^3 which are competitively available due to proximity to the Celgar mill.

1. Industrial Forestry Service Ltd., 1990, "Excerpts From Stewart and Ewing Associates Ltd. 1989 B.C. Interior Chip Production for Chip Producers in the Celgar Supply Regions," (based on Celgar's supply units), Technical Hearings Document No. 2.

2. Mr. V. Holm, Ministry of Forests, Technical Hearings Transcripts, Vol. 1, pp. 123-125.

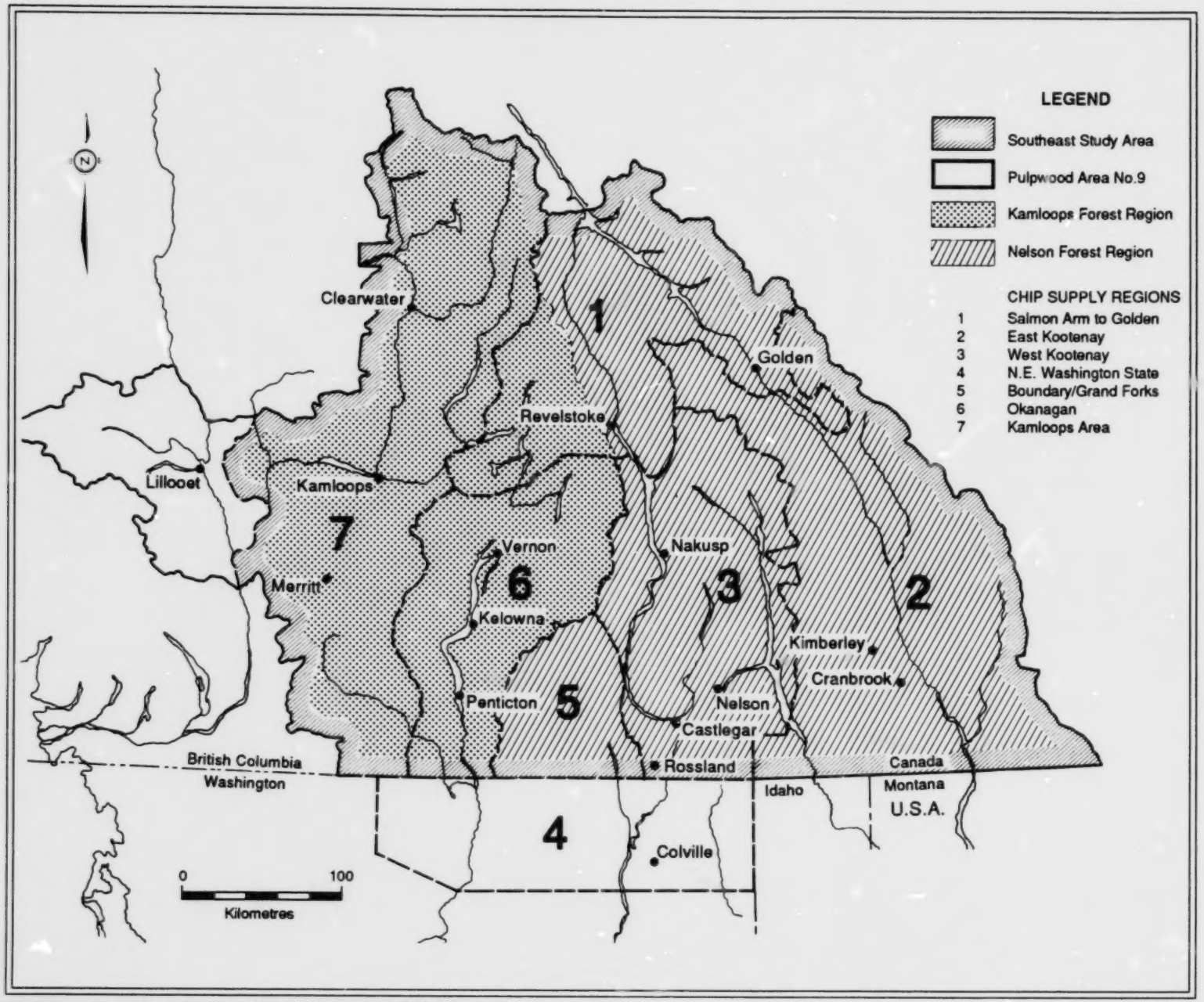


FIGURE 3. CELGAR PULP MILL WOOD CHIP SUPPLY REGIONS.

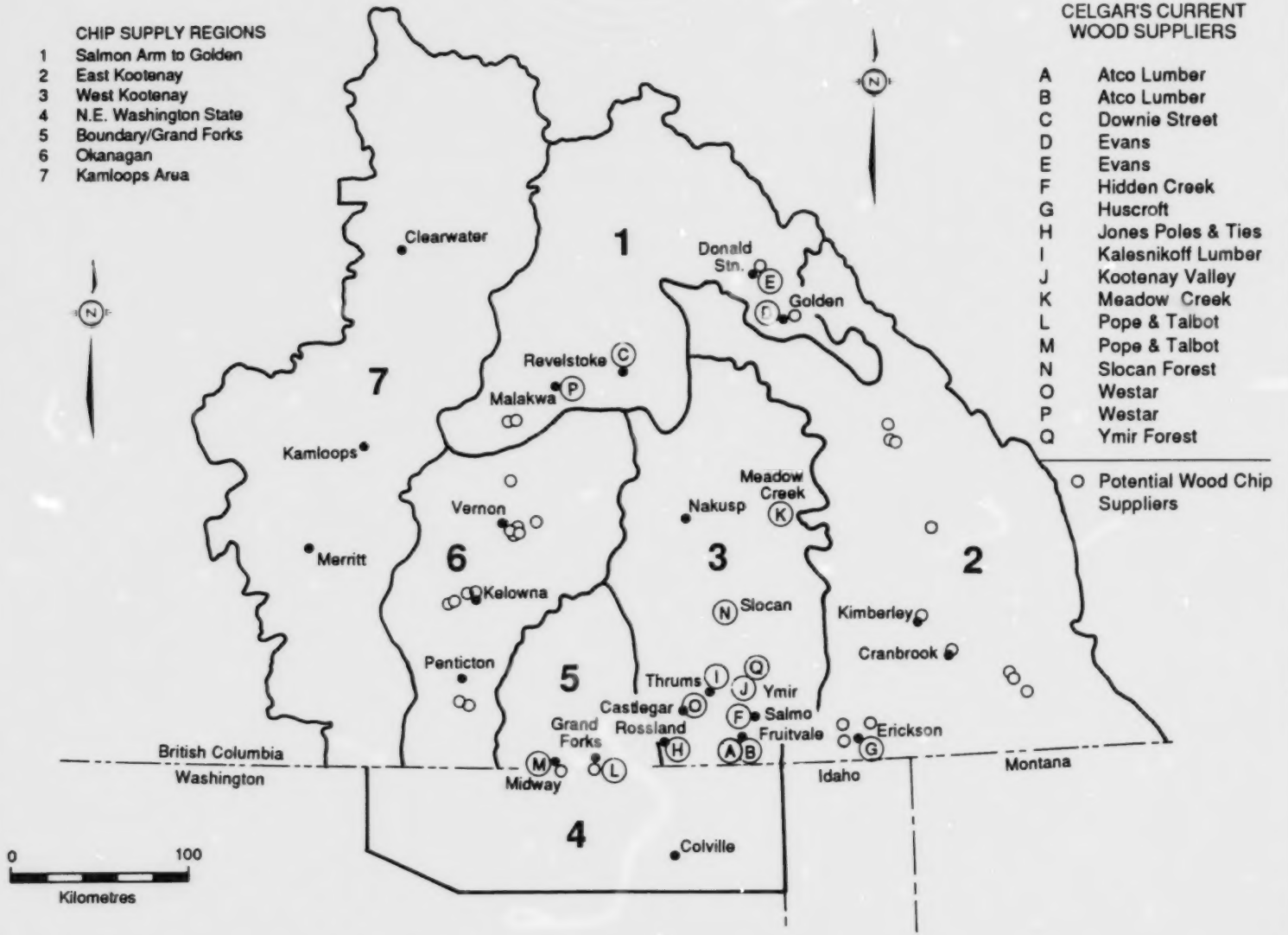


FIGURE 4. SAWMILLS IN THE CELGAR WOOD CHIP SUPPLY REGIONS (CURRENT AND POTENTIAL SUPPLIERS).

TABLE 1: SAWMILL WOOD CHIP SUPPLY IN SOUTHEAST BRITISH COLUMBIA AND WASHINGTON STATE (MILLIONS OF M^3)

	Celgar Supply Region		Southeast B.C.		
	IFS 1988[a]	S&E 1989[a]	Reid Collins 1987[b]	MOF 1987[c]	MOF 1989[d]
Sawmill Chip Production from Interior Sawmills	6.05	6.14	5.95	5.57	6.48
Pulp Mill Consumption (Celgar, Crestbrook, Weyerhaeuser)	3.76	3.69	3.66	4.01	3.73
Interior B.C. Surplus Sawmill Chips	2.29	2.45	2.29	1.56	2.75
Washington Surplus Sawmill Chips	0.11*	0.11*	0.11*	0.11*	0.11*
Total Surplus Sawmill Chips	2.40	2.56	2.40	1.67	2.86

Sources:
a) Industrial Forestry Service Ltd., "Comparison of 1988 IFS and 1989 Stewart and Ewing Surveys", 1990; consumption includes use of chips from Alberta at Crestbrook.
b) Appendix D, Volume 2, Stage II Report, Celgar Pulp Co., 1990; Pulp Chip Availability in B.C.: 1987, Reid Collins FRDA Report 061, 1989.
c) Southeast B.C. Fibre Resource Study, Ministry of Forests, 1989; consumption of chips is based on pulp mills operating at capacity.
d) Ministry of Forests, Technical Hearings Document No. 15; Volume 1, Technical Hearings Transcripts, Celgar Expansion Review Panel, 1990; consumption of wood chips is based on actual consumption in 1989.

* Based on the 1988 IFS study estimate of unutilized wood chips in northern Washington State (Region 4 - Figure 3), assumption carried throughout calculations based on other studies.
Note: BDU data has been converted at a factor of 2.8 m^3/BDU; Reid Collins and Ministry of Forests studies have slightly different boundaries; Reid Collins estimates are based on projected production and actual consumption.

3.2.2 Sawmill Wood Chip Sources

Celgar proposes to purchase approximately 40 - 50% of the supply of sawmill wood chips which are surplus to local pulp mills, in order to obtain the 1.1 million m^3 of additional wood chips required for mill expansion. This incremental requirement would originate from sawmill wood chips which are currently shipped out of interior British Columbia, chips available from Washington State, plus a small volume which is currently discarded due to a lack of markets.

Table 2 summarizes the data presented to the Panel on the production and disposition of sawmill wood chips. The total chip production, including Washington State, is about 7 million m^3. Celgar proposes to purchase its incremental 1.1 million m^3 requirements from the 2.45 million m^3 in the region which are currently shipped to the coast (Fletcher Challenge), exported to the U.S., or acquired by Fibreco for export, and from the 176,700 m^3 of wood chips which they consider to be competitively available in northeast Washington.

Celgar stated that specific sawmill sources are subject to future contract negotiation with individual sawmills. It was argued by Celgar that these sources of wood chips could be secured principally due to the lower transportation costs and higher prices offered by the Celgar mill.

Some intervenors questioned Celgar's ability to acquire sufficient chips. The Kootenay Coalition for an EARP, for example, pointed out that 650,000 m^3 produced in the Okanagan (1988) may not be available to Celgar since they are utilized domestically.[3] Indeed, some 615,400 m^3 were shipped from regions 6 (Okanagan) and 7 (Kamloops) to Fletcher Challenge pulp mills on the coast in 1989 (Table 2). It is uncertain how much of this supply would be diverted to Celgar, since Fletcher Challenge's intergrated operations may continue to draw from their own sawmills. However, Celgar proposes to obtain only 342,900 m^3 from the Okanagan region where 1.5 million m^3 is currently produced annually.

Other information was presented indicating that surplus chips currently exported would be diverted to a domestic user such as the proposed mill, particularly given the transportation and price advantages. It was stated that no export restrictions impede the sale of chips from U.S. sawmills to Canada currently and that none appear likely in the future.[4] The Panel heard indications that the Government of British Columbia has a policy of restricting chip exports if the chips are needed domestically, through a chip export advisory committee[5].

3. Kootenay Coalition for an EARP, Final Submission to CERP, November 7, 1990.
4. Mr. J. McWilliams, Wood Products Consultant, Technical Hearings Transcripts, Vol. 1, p. 239.
5. Ibid.

TABLE 2: SAWMILL WOOD CHIP PRODUCTION AND DISPOSITION BY CELGAR PULP MILL SUPPLY REGIONS (THOUSANDS OF M^3)

Region	1988 Production[a]	1989 Production[b]	1989 Celgar Consumption[b]	1989 Crestbrook/ Weyerhaeuser[b]	1989 Fletcher Challenge[b]	1989 Export/ Fibreco[b]	1995 Proposed Requirement[c]	1995 Incremental Requirement[d]
1	530.7	404.6	78.7	87.1	-	238.9	441.8	363.1
2	1,132.1	1,073.4	2.8	1,008.8	-	61.8	87.0	84.2
3	907.7	747.5	747.5	-	-	-	857.4	109.9
4	994.0*	no data	0*	0*	-	-	176.7	176.7
5	294.2	446.8	202.3	-	-	244.5	294.2	91.9
6	1,211.1	1,497.7	-	281.0	514.2	702.5	342.9	342.9
7	1,969.8	1,969.8	-	1,284.2	101.2	584.5	-	-
Total	7,039.6	6,139.8	1,031.3	2,661.1	615.4	1,832.2	2,200.0	1,168.7
		994.0 (U.S.)						
		7,133.8						

Source:

a) Table 1, Volume 2, Stage II Report, Celgar Pulp Co., 1990.
b) 1989 Interior Chip Scenario for the Province of British Columbia, Stewart and Ewing Associates Ltd., 1990.
c) Table 3, Volume 2, Stage II Report, Celgar Pulp Co., 1990.
d) Difference between 1995 proposed requirement and 1989 Celgar consumption.
e) Based on 1988 projections, Table 2, Volume 2, Stage II Report, Celgar Pulp Co.
* Celgar states that 109,173 m^3 of the total 994,000 m^3 chip production in Washington State is not utilized in the area, and another 67,500 m^3 is utilized but not covered by long-term contract and with lower freight cost to Castlegar, resulting in 176,673 m^3 potentially available for export to Celgar.

Sawmills which could potentially supply Celgar are shown on Figure 4. Sawmill operators indicated that the sale of byproduct wood chips often represents the margin of income which enables their operation to be viable. They welcomed the opportunity to sell byproduct chips for pulp production in southeastern British Columbia. Westar Timber Ltd., for example, indicated that it produced 330,470 m^3 of sawmill chips in 1989 (one-third of Celgar's current requirement), and burned an estimated 60,000 m^3 of chips due to a lack of accessible markets.

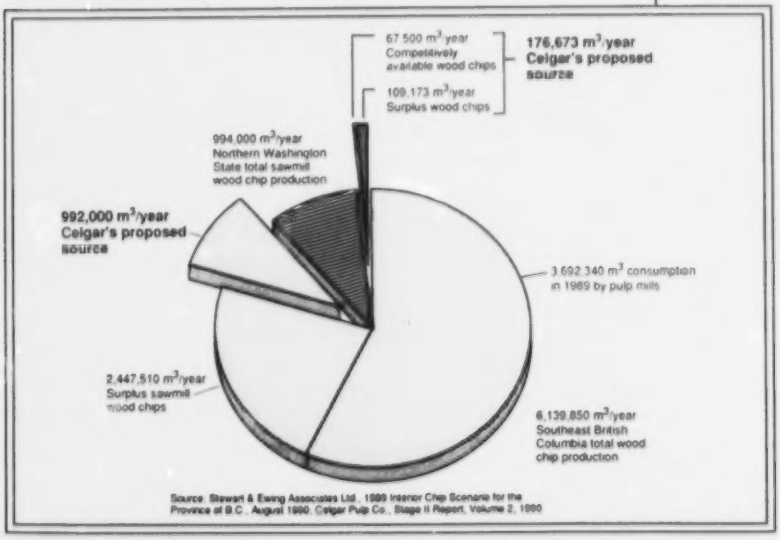

67,500 m³/year
Competitively available wood chips
109,173 m³/year
Surplus wood chips
176,673 m³/year
Celgar's proposed source
994,000 m³/year
Northern Washington State total sawmill wood chip production
992,000 m³/year
Celgar's proposed source
3,692,340 m³ consumption in 1989 by pulp mills
2,447,510 m³/year
Surplus sawmill wood chips
6,139,850 m³/year
Southeast British Columbia total wood chip production
Source: Stewart & Ewing Associates Ltd., 1989 Interior Chip Scenario for the Province of B.C., August 1990. Celgar Pulp Co., Stage II Report, Volume 2, 1990

FIGURE 5. SAWMILL WOOD CHIP SUPPLY IN SOUTHEAST BRITISH COLUMBIA AND WASHINGTON STATE.

It is apparent from the various sources of data that there is a substantial surplus of sawmill wood chips but this surplus will vary with the state of the sawmilling industry. Celgar has a distinct advantage in securing contracts within the Kootenay region and Washington State. They may have a less competitive advantage in securing the anticipated 15% of supplies from the Okanagan region. However, even if Celgar is unable to acquire chips from the Okanagan region currently being shipped to mills on the coast, there still remains a current supply of at least 1.8 million m^3 annually.

In the uncommon event of decreased lumber and sawmill chip production coinciding with a strong pulp market, the surplus could potentially decrease to a level approximating the proposed 1.1 million m^3 of additional wood chip requirements. However, comparative economic advantages of the Celgar mill in purchasing surplus chips will minimize the potential for a shortfall.

The Panel concludes that there are sufficient supplies of sawmill wood chips to provide for the projected requirements.

3.3 ROUND WOOD CHIP AVAILABILITY

3.3.1 Round Wood Supply

Figure 6 shows the available pulp wood supply which could be used to meet Celgar's proposed round wood requirements. Four types of pulp wood are available: pulp logs within the sawlog Annual Allowable Cut, logging waste and small wood within the AAC land base,

small pine within the AAC land base, and pulp logs outside of the sawlog AAC.

AAC Pulp Log Supply

The available data on round wood supplies which could serve the proposed Celgar requirements are derived from the Ministry of Forests' "Southeast British Columbia Fibre Resource Study" (1989). That report indicates that almost 1.3 million m^3 of pulp logs occur within the current AAC land base. A small portion (less than 100,000 m^3) of this volume is sold to Fibreco for export. Therefore, according to Ministry of Forests data, an estimated 1.2 million m^3 of pulp logs are potentially available under existing forest tenures. These are pulp stands within the sawlog allowable cut that are available to existing tenures but are currently not harvested due to limited markets for the pulp logs.

The proposed requirement for pulp logs makes up 14% of the estimated available pulp timber stands within the approved sawlog AAC. Other sources within the current AAC are also available.

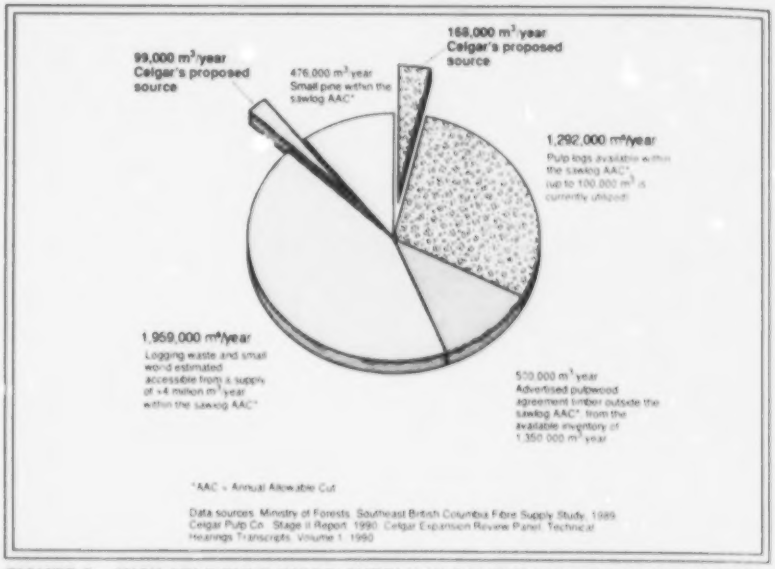

168,000 m³/year
Celgar's proposed source
99,000 m³/year
Celgar's proposed source
476,000 m³/year
Small pine within the sawlog AAC*
1,292,000 m³/year
Pulp logs available within the sawlog AAC*; (up to 100,000 m³ is currently shipped)
1,959,000 m³/year
Logging waste and small wood estimated accessible from a supply of >4 million m³/year within the sawlog AAC*
500,000 m³/year
Advertised pulpwood agreement timber outside the sawlog AAC*, from the available inventory of 1,350,000 m³/year
*AAC = Annual Allowable Cut
Data sources: Ministry of Forests, Southeast British Columbia Fibre Supply Study, 1989; Celgar Pulp Co., Stage II Report, 1990; Celgar Expansion Review Panel, Technical Hearings Transcripts, Volume 1, 1990

FIGURE 6. AVAILABLE PULP WOOD SUPPLY IN SOUTHEAST BRITISH COLUMBIA.

AAC Waste Wood, Other Small Wood and Small Pine

The Ministry of Forests also considered other potential sources of pulp wood associated with sawlog harvesting. These included waste wood, small stems, tops, deadwood, understory thinnings, other small wood and small pine. The Ministry's representative stated that an estimated volume of about 2 million m^3 of recoverable fibre is available from these sources. This is based on estimates which assume that less than half of the (>4 million m^3) logging waste on average, and around 30% in most Timber Supply Area (TSA) units, are available for pulp harvest. According to Ministry staff, this volume is expected to be removed before any pulp log harvesting.[6] Celgar proposes to utilize about 4% of this estimated available waste wood and small wood supply. The economic efficiencies in utilizing this source however, may depend upon market prices and the availability of other sources.

Non AAC Pulp Log Supply

The Ministry of Forests also assessed pulp log timber outside of the current AAC. This included problem forest stands comprising decadent and stagnant timber that is mainly useful as raw material for pulp but also contains some sawlog material. These sources excluded low sites, deciduous types, non-sufficiently restocked areas and environmentally sensitive areas. The available volume of this timber was estimated to be 1.35 million m^3 annually.[7]

The estimated volume of pulp logs was reduced by the Ministry of Forests on the basis that the 40-year rotation period assumed in the study was too short, and that additional environmentally sensitive areas should be excluded.[8] The resulting available 0.652 million m^3 of problem stands (Table 3)was adjusted to a volume of 0.5 million m^3 of wood fibre which is currently being offered by the Ministry of Forests under a pulpwood agreement.

These three types of available round wood chip supply, totalling 3.7 million m^3 (1.2, 2.0 and 0.5 million m^3), are substantially greater than the 267,000 m^3 of wood required in Celgar's proposed mill expansion.

3.3.2 Round Wood Sources

The 267,000 m^3 of pulp grade round wood which is proposed for chipping could originate from various sources - logging waste, pulp stands bypassed in sawlog operations and pulp logs in problem forest stands excluded from the allowable cut. In total, 4.38 million m^3/year of pulp timber are available from the West and East Kootenays and Kamloops regions (Table 3). Within the West Kootenay TSAs alone, 1.26 million m^3 are available, according to Ministry of Forests data.

Celgar indicated that they intend to obtain 168,000 m^3 of pulp logs from three licencees in the region (Figure 6). The three proposed sources, which are also required by licence to harvest pulp logs alongside sawlog operations, are Westar Timber Ltd. (115,000 m^3), Downie Street Sawmills Ltd. (46,746 m^3) and Joe Kozak Sawmill Ltd. (6,154 m^3).[9] Celgar also intends to obtain 99,000 m^3 from logging waste in current sawlog operations (Figure 6).

Westar Timber stated in their brief that within TFL No. 23, north of Castlegar, they have a quota of 162,000 m^3 of pulp grade timber, and an additional supply of 25,000 m^3 from purchased timber stands. They are required by licence to harvest pulp wood along with sawlogs, although the costs of harvesting pulp wood have exceeded the revenues due to the lack of markets. A determining factor in profitability is

6. Mr. V. Holm, Ministry of Forests, op. cit., Vol. 1, p. 129.
7. Ministry of Forests, Technical Hearings Document No. 15, October, 1990.
8. Mr. V. Holm, Ministry of Forests, op. cit., p.128.
9. Celgar Pulp Co., Stage II Report, Vol. 2, "Fibre Sourcing and Transportation," p.7.

TABLE 3: PULP WOOD SOURCES IN SOUTHEAST BRITISH COLUMBIA (THOUSANDS OF M^3/YR.)

	Kamloops	E. Kootenay	W. Kootenay	Total
Incremental Fibre				
Small Pine	289	160	27	476
Logging Waste	167	48	104	319
Tops	295	104	122	521
Deadwood	628	214	277	1,119
Total	1,379	526	530	2,435
Pulp Log Fibre				
Pulp Logs	700	196	396	1,292
Problem Stands	209	105	338	652
Total	909	301	734	1,944
Total Incremental and Pulp Log Fibre	2,288	827	1,264	4,379

Source: "Summary of Fibre Volumes by Supply Unit", Southeast British Columbia Fibre Resource Study, Ministry of Forests, 1989.

apparently the cost of transportation from Revelstoke which is estimated at $17/m^3$ to Cache Creek chipping facilities (for export) versus $6/m^3$ to Castlegar.[10]

Other tenure holders, notably Slocan Forest Products, supported this evidence, indicating that high transportation costs prohibited it from selling chips elsewhere.[11]

Figure 6 summarizes the pulp wood supply data, showing Celgar's proposed volumes in relation to the total annual available supplies of pulp wood timber. The projected requirement involves 7.3% of the estimated available pulp wood (Figure 6 - 1.2, 1.96 and 0.476 million m^3) within the AAC and 6.1% of the total pulp wood available in southeast British Columbia (Table 3 - 4.379 million m^3). It is clear that the proposed requirements are a small proportion of the total supply, with or without the proposed Pulpwood Agreement.

The Panel concludes that there are more than sufficient round wood supplies within existing tenures to provide for the projected requirements.

3.4 SECURITY OF WOOD CHIP SUPPLY

3.4.1 Sustainability of Wood Supply

Current Practices

The Panel heard conflicting views about the long term sustainability of wood supply. Celgar presented timber yield data from Ministry of Forests TSA analysis which showed projected yield for the next 200 years.[12] Harvest levels were predicted to remain constant in many of the TSAs, with the exception of Golden, Kootenay Lake and Revelstoke TSAs where declines are expected after 40 years, and Okanagan TSA where a decline in current harvest is expected after 25 years. These declines were associated with the current high proportion of mature timber within these areas. Celgar's consultant stated that the short term harvest may exceed the long run sustainable yield due to a high proportion of mature timber, noting that some TSAs in the province have much less mature timber and can not support, in the short term, the long run sustainable yield.[13]

Various participants questioned Celgar's estimates of sustainability of wood supply and doubted the reliability of Ministry of Forests data upon which they are based. The Department of Fisheries and Oceans, for example, stated that sawlog supply data within TSA reports are not adequate to determine the future supply of residual wood chips. They noted the current 22% overcommitment in the 1990 AAC within the five TSAs in the region and the likely future reduction in AAC. On the basis of TSA data, a shortfall of timber within existing operations was predicted, resulting in a need to harvest new areas of problem forest types.[14] This study, however, did not take into account Celgar's proposed use of surplus chips from sawmills as their primary source of incremental fibre. The Department of Fisheries and Oceans' conclusions assumed that Celgar would require rights to harvest roundwood under Pulpwood Agreement No. 9 to meet the full additional requirement for fibre in support of the proposed expansion.

The Kootenay Coalition for an EARP also challenged the reliability of wood chip supply data. They argued that Celgar's projections were made using inadequate data and procedures for determining sustained yield, and a best case scenario which assumed that the existing amount of byproduct chips will be available for the life time of the mill.[15] The Valhalla Society also disputed Celgar's argument, providing data showing provincial harvest levels above the long run sustained yield. Many of the concerns focussed on the effects of increasing pulp wood harvesting as a result of potential future declines in sawmill wood chips.

Intensive Forestry

Information was also provided on the potential increases in wood chip supply from increased silviculture. The opportunities from intensive forestry were described, along with data comparing Sweden and British Columbia, and providing

10. Mr. D. Madlung, Westar Timber Ltd., Technical Hearings Transcripts, Vol. 1, p.47.
11. Mr. I. Barber, Community Hearings Transcripts, Vol. 1, p. 281.
12. Stewart and Ewing Associates Ltd., op. cit.
13. Mr. H. Gairns, Technical Hearings Transcripts, Vol. 1, pp. 25-6.
14. Department of the Environment and the Department of Fisheries and Oceans, Technical Hearings Document No. 55, p.17.
15. Kootenay Coalition for an EARP, op. cit.

estimates of potential yield from increased silviculture investment in the province. A study funded by the Regional District of Central Kootnay, for example, estimated that the AAC in the West Kootenays would drop by 20% with no silviculture but could increase 56% with greater investment.[16] The Science Council of British Columbia report on forestry research and development also showed evidence of significant returns from greater silviculture.[17]

Representatives from the Kootenay Coalition for an EARP, on the other hand, suggested that intensive silvicultural treatments are relatively untried in the Nelson Forest Region and that the biological results are uncertain.[18]

Sustainability of wood supply was also tied to a trend toward increased standards of utilization, deriving greater use of fibre from each hectare of forest land. The Ministry of Forests argued that increased demand for pulpwood chips would encourage logging operators to use wood which is currently discarded and to handle wood chips more efficiently.

3.4.2 Vulnerability to Supply Disruptions and Shortfalls

Potential AAC Reductions

Several presentations indicated that a reduction in the AAC in the region is likely. Some argued that this will be due to an unsustainable rate of harvest, or "falldown effect", on the sawlog industry. Others suggested that withdrawals from the land base for timber production due to parks, reserves and other land uses will cause a lowering of the allowable cut.

The Kootenay Coalition for an EARP stated that reductions in AAC are necessary to maintain forest productivity. They argued that a lower rate of harvest is required due to the need to provide continual supplies of coarse woody and large organic debris to ecosystems, the need to lengthen the rotation ages in order to grow trees to true culmination age and to maintain wood quality, and the need to consider soil degradation associated with logging practices.[19]

The Valhalla Society also stated that declines in the AAC were inevitable, principally due to the "falldown" effect in timber supply. The Valhalla Society contended that estimates of available wood supplies (e.g. 1989 Southeast Fibre Resource Study) were based on obsolete information and that more current estimates indicated a decrease of 15-30% in the Kootenay TSA. The Valhalla Society suggested further that estimates of the timber resource land base had inadequate allowances for non-timber resource values and that public opinion would require that more wilderness areas be reserved.[20]

Existing TSAs, approved in 1981, are normally reassessed after 5 years but due to staff shortages and other reasons, the revisions have not occurred as originally scheduled.[21] The precise extent and timing of changes in the AAC remain uncertain. Most of the TSA plans in the chip supply regions have not been amended since 1981.

Potential Sawmill Production Disruptions

Celgar noted that the conditions which might cause a shortfall in wood chip supply include competition from a new wood chip consumer, temporary closure of sawmills and reductions in the AAC.[22] They stated that in the event sawmills are not producing chips, increased supplies would be derived from chipping pulp logs. Additionally, they have applied for a Pulpwood Agreement to provide wood chip supplies in such circumstances.

The Ministry of Forests indicated that a downturn in sawmill production would reduce the availability of surplus wood chips but that such a shortage would also stimulate a market for pulp logs or low-quality sawlogs to be processed into wood chips. The supply of pulp grade timber, according to Ministry of Forests data, is sufficient to meet all of Celgar's wood chip requirements if, in the extreme situation, no residual chips were available from sawmills.

3.4.3 Increased Sawmill Recovery

Improvements in sawmilling technology, according to some presentations, could result in a higher recovery of lumber and a decreased supply of residual wood chips. However, very limited data were provided on the specific effects of potential improved sawmill recovery on wood chip supplies.

The sustainability of wood chip supply and the vulnerability to supply disruptions and shortfalls depend upon future reductions in the AAC, changing standards of wood utilization and investments in silviculture. Over the long term, decreases in the AAC are likely in southeastern British Columbia. But even with a substantial reduction, there would remain a sufficient supply to provide for the proposed mill expansion. Moreover, some of the effects of reduced AAC could be offset by gains from silviculture and intensive forestry. Round wood sources of wood chips within existing tenures are more than sufficient to offset the risks associated with a decrease in the supply of sawmill chips.

3.5 Effects of Potential Additional Harvesting

3.5.1 Forest Management and Watershed Effects

Many residents of the West Kootenays expressed their concerns about the past and proposed logging in the region. They described their fears about current harvesting as well as expansion of harvesting due to a potential Pulpwood Agreement. Some argued that if supplies of sawmill chips decline, round wood sources could increase beyond the proposed 10% supply. Much of the round wood supply will originate from wood normally left behind in sawlog harvest areas, but some will come from discrete pulp wood stands

16. T.M. Thomson & Assoc. Ltd., "Intensive Forest Management Plan for the Kootenays", Regional District of Central Kootenay, 1986.
17. Science Council of B.C., "Forestry Research and Development in British Columbia: A Vision for the Future", October, 1989.
18. Mr. H. Hammond, Technical Hearings Trancripts, Vol. 10, p. 2100-1.
19. Ibid.
20. Mr. G. Copeland, Valhalla Society, Community Hearings Transcripts, Vol. 3, p.836.
21. Mr. O. Travers, Department of Fisheries and Oceans, Technical Hearings Transcripts, Vol. 1, p. 166.
22. Celgar Pulp Company, Additional Information, p. 77.

within lands included in the AAC calculations.

Problem forest stands containing pulp wood sources often occur on lands with physical or economic constraints which have discouraged harvesting in the past. The Ministry of Forests notes:

> Until there is a market for the pulp logs the decadent hemlock and balsam and stagnant pine stands will remain largely uneconomic to log. The estimate of the volume of recoverable fibre depends partly on an "operability line" delineated by the Forest Service. As the price of fibre increases the operability line will move further back or up the slope and in many areas increase the area available for harvest. A substantial amount of fibre will be wasted if operators are forced to fell and burn the low grade logs left after removing roundwood suitable for lumber production.[23]

It is this induced expansion of logging areas, particularly in community watersheds and especially those which provide domestic water supply, which creates the greatest public concern. Many groups felt that overcutting is already occurring and that leaving pulp wood is essential for the stability and productivity of forest ecosystems. The importance of old growth forest and the effects of clearcutting practices were mentioned many times. Particular concerns were expressed about the multitude of forest values which could be jeopardized by logging:

> One of the fundamental positions of the West Arm Watershed Alliance is that this land is not just timber lot. It represents other values including the character of landscape, pure water, wildlife habitat, wilderness, old growth forests, a burgeoning tourist industry, and an environment unsurpassed anywhere in the world for beauty.
>
> We believe that these other values are not being adequately addressed, and we're appealing for the instigation of a comprehensive land use plan to properly priorize these values. We are actively seeking the cessation of resource development until this kind of plan has been developed for our valley.[24]

The Department of Fisheries and Oceans also spoke of their concerns about potential impacts of harvesting on fish habitat. They suggested the need to look closely at the condition of specific watersheds and the thresholds beyond which logging can create major changes to watershed stability. They also referred to procedures for mitigating adverse effects and proposed guidelines for logging to protect fish and wildlife in the interior of the province.[25]

The Ministry of Forests also recognized the increasing concern about the environmental effects of logging and the need for integrated resource management. They provided an outline of proposed new procedures for forest planning, including "Analysis Framework for Integrated Resource Management" (AFIRM) and the "Forest Development Review Process".

The extensive expressions of many participants' concern about logging in the west Kootenays reflect the growing dissatisfaction with traditional approaches to forest management which the Panel heard. New approaches were proposed which can build public trust in forest management through better data, more integrated planning and meaningful public involvement. During the course of the hearings, four areas of concern were identified as the most prominent aspects of forest management which require improvement:

(a) *detailed inventory data* on the array of forest resource values which provide the basis for land and resource use allocation decisions;

(b) *watershed stability* and the effects of different sizes and rates of harvest and related road building activities on soils, hydrology, landslides, and debris flows;

(c) *integrated resource management* procedures which can provide more explicit assurances of protection for fish and wildlife habitat and community watershed uses, and which incorporate the concept of "sustainable development";

(d) *public involvement methods* which recognize public forest lands as an important part of communities and local community decision making.

Recommendation 1

Although management of provincial Crown forests was excluded from the Panel's mandate, the Panel recognizes that there may be governmental decisions regarding harvesting which pertain to the supply of wood chips for Celgar and which have undesirable environmental effects. Such decisions may include approval of forest management plans and permits under existing tenures, rights to additional harvesting under Pulpwood Agreement No. 9, and changes to forest management resulting from the work of the Forest Resources Commission. The Panel recommends that any decisions take into consideration the protection of high elevation forests, community watersheds, fish and wildlife habitat, soil quality and recreational and aesthetic use of the forests in southeastern British Columbia.

Recommendation 2

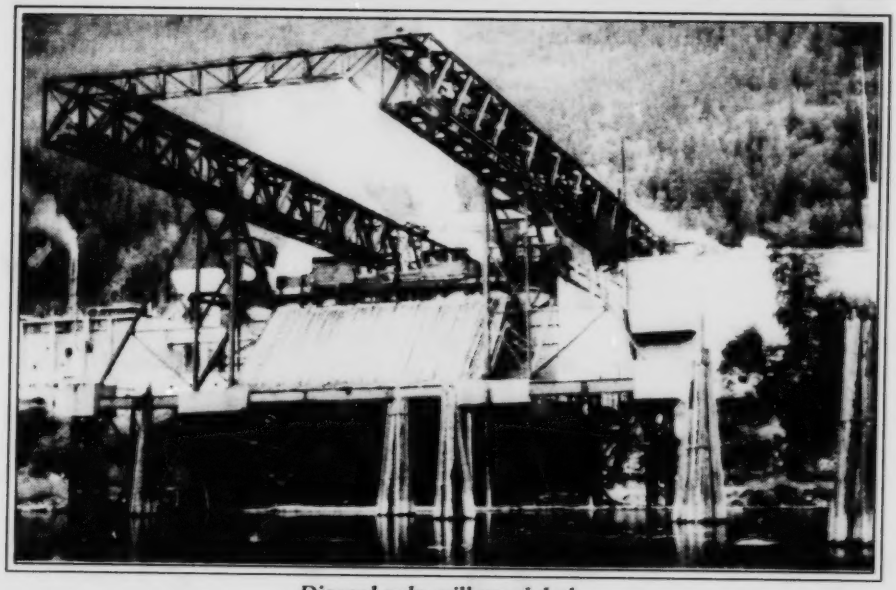
The Panel specifically recommends to the Forest Resources Commission that it consider initiating a comprehensive program of local resource use plans in southeastern British Columbia, including:

- ***identifying designated areas for new and revised local resource use plans;***
- ***establishing detailed planning procedures which explicitly incorporate industry and public objectives for integrated and sustainable forest management and ecosystem variables which may have been overlooked in the past;***

23 . Ministry of Forests, Southeast B.C. Fibre Study, 1988, Technical Hearings Document No. 16, p. 21.

24 . Mr. R. Bridge, West Arm Watershed Alliance, Community Hearings Transcripts, Vol. 3, pp. 124-125.

25 . Mr. J. Payne, Department of Fisheries and Oceans, Technical Hearings Transcripts, Vol. 1, p. 206.



Disused pulp mill wood deck.

- ***providing public involvement in the selection of land use options and forest management practices;***
- ***preparing a program and schedule for undertaking these plans; and***
- ***preparing an annual report on the progress and results of this program.***

In a separate submission, the Panel will be formally transmitting to the Minister of Forests and to the Chairman of the Forest Resources Commission, the representation received on the environmental impact of forest management practices.

3.5.2 Log Transport and Handling Effects

The proposal to reactivate the woodroom and to transport 267,000 m³/year of logs to the mill will present some additional environmental and social effects. These could occur due to wood debris from log transport and handling on the Arrow Lakes and Columbia River, and the additional truck traffic from logging truck traffic. The water quality concerns are discussed in Chapter 6.

The amount of truck transport of pulp logs is uncertain. Most logs are likely to arrive by water, but assuming that 10 - 25% are transported by road, this would result in an estimated range of 1,000 - 2,700 truck deliveries annually (25 m³ per pulp log truckload).

3.6 Hog Fuel Utilization

"Hog fuel" is a mixture of sawmill residues consisting chiefly of bark, shavings and sawdust. Westar sawmill adjacent to the Celgar pulp mill produces approximately 1,000 wet tons per day during full operation. The Celgar pulp mill currently burns 95% of this hog fuel and pays Westar an amount equivalent to the energy value of the material.

The recovery boiler in the proposed pulp mill will have a sufficient capacity to drive a large turbine and generate most of the steam required in the pulping process. The mill would be 90% energy self-sufficient. The only hog fuel that would be burned is the bark from the relatively small volume of logs which are to be chipped on site. Westar would therefore be required to find another use for the hog fuel or a means of disposal.

Westar has signed a letter of intent with Northwest Energy to provide hog fuel for electrical generation and sale to the B.C. Hydro system. The cost of the generating facility would be $100-$130 million and would take five years to organize and build.

Another option for the use of hog fuel is for Celgar to burn the material using their surplus boiler capacity in order to co-generate steam for pulp mill processes and electricity for sale to the West Kootenay Power or B.C. Hydro grid. Celgar does not plan to dismantle the existing boilers, which could be used for co-generation purposes. West Kootenay Power has an interest in this option although the expressed proposal to date has not been financially attractive enough to Celgar. Further consideration is being given to possible co-generation projects.

Recommendation 3

The Panel recommends that the provincial Ministry of Energy, Mines and Petroleum Resources and Ministry of Environment undertake an evaluation of options for the use or disposal of hog fuel from Westar's sawmill made surplus by the proposed Celgar modernization, and the opportunities for energy production from this resource.

Chapter 4: Transportation Issues

4.1 Transportation Requirements

The proposed project involves the shipment of incoming supplies of wood chips and logs, incoming chemicals and other materials and outgoing woodpulp.

Table 4: Current and Proposed Commodity Shipments

	1989	1995	% change
Incoming			
Chemical/other truckloads[a]			
Highway 3 - west	449	406	-10
Highway 3 - east	196	250	+28
Total	645	656	+1.7
Chemical/other rail carloads[b]	376	569	+51
Woodchip truckloads[c]			
Salmon Arm - Golden	1,568	8,931	
Cranbrook - Golden	28	1,864	
West Kootenays	11,391	12,422	
Washington State	0	4,593	
Boundary	4,577	7,398	
Okanagan	0	6,565	
Total chip truckloads	17,564	41,773	+138
Woodchip rail carloads[d]	342	0	
Outgoing			
Woodpulp truckloads[e]			
Highway 3 - Vancouver	1,183	2,599	+120
Woodpulp rail carloads[e]			
CPR - Vancouver	1,117	4,269	+282
CPR - Eastbound	1,158	1,699	+47
Total all truckloads	19,392	45,028	+132
Total all rail carloads	2,993	6,537	+118

a Exhibit II - 4, Ibid., 1990.

b Exhibit II - 3, Ibid., 1990.

c Exhibit II - 6 and III - 2, Ibid., 1990.

d Exhibit II - 6, Ibid., 1990; in the first four months of 1990, no wood chips moved to Celgar by rail.

e Exhibit II - 1, Shipments of Woodpulp, Volume 2, Transportation, Stage II Report, Celgar Pulp Co., 1990.

Celgar's proposal would substantially increase transportation by truck of the wood chip supply from the surrounding regions. The company's submissions also evaluated barge and rail transportation alternatives, at government's request.

The current inflow of wood chips is estimated at 1.1 million m^3. Almost one-third of this volume arrives by conveyor from the adjacent Westar sawmill. The remaining two-thirds is shipped by truck and rail. The Stage II Report presents data showing the declining proportion of railcar movement of wood chips, from 26% of total volume in 1987 to zero in 1990.

The proposed mill would involve the movement of wood fibre to produce 2.47 million m^3, 90% of which is expected to be wood chips from sawmills and 10% of which is expected to be pulp logs for chipping at Celgar. As shown in Table 4, the current annual number of chip truckloads is projected to increase from 17,564 to 41,773 in 1995, a 138% increase.

The incoming supply of chemicals and miscellaneous products arrives by truck and rail. The total truckloads have historically ranged between 645 - 1,026 per year between 1985 and 1990. The rail carloads have averaged about 400 per year. Celgar anticipates shifts between source of materials and replacement of some chemicals with others due to changes in the pulp-making process. Table 4 identifies a 51% increase in rail carloads and 1.7% increase in truckloads of these incoming shipments. These increases do not appear problematic.

The increased production of woodpulp would result in more than the doubling of outgoing shipments. An average of 11% of the total volume of product is moved by truck and this proportion is expected to remain constant. The remainder is shipped by CP Rail to Vancouver (via Golden) and to central and eastern North America (via Lethbridge).

Table 4 shows the proposed changes to shipments of woodpulp. Truckloads are estimated to increase from 1,183 in 1989 to 2,599 in 1995. Celgar proposes that all of the current and predicted shipments of pulp by truck are backhaul movements of trucks which would otherwise return to Vancouver empty. As a result, very little if any increase in woodpulp truck traffic is predicted to occur with mill expansion. Rail shipments of woodpulp currently involve 2,275 rail carloads. This is expected to increase to 5,968 carloads in 1995.

Overall, total truckload shipments will increase 132% from 19,392 to 45,028. Total rail carloads will increase 118%, from 2,993 to 6,537. In addition, an unknown number of logging trucks will be transporting logs to the mill. If 10% of the pulp logs arrive by truck, this will involve an estimated 1,068 truckloads annually[1].

1. Based on 10% of 267,000 m^3 of pulp logs divided by 25m^3 per truck load.

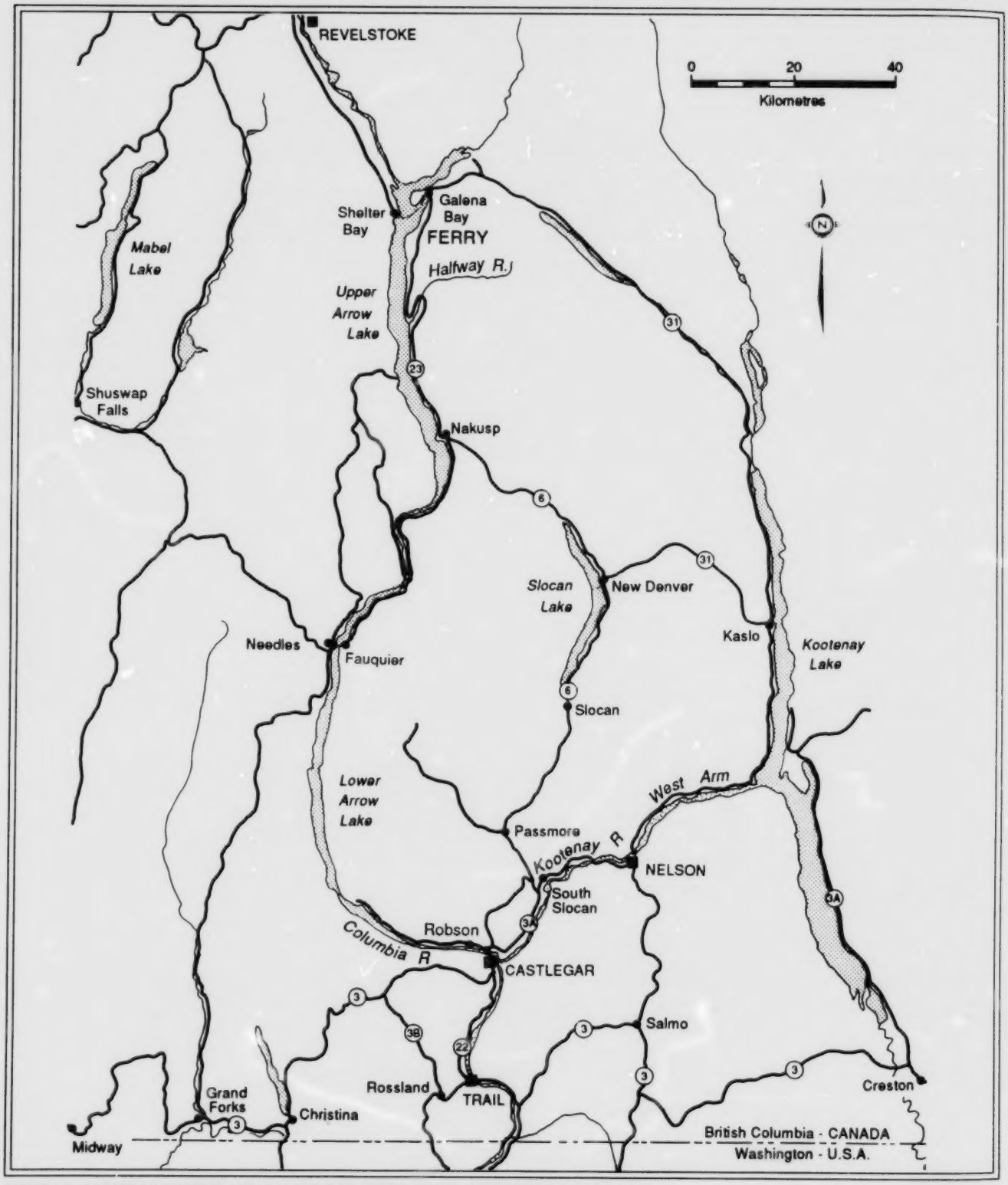


FIGURE 7. HIGHWAY SYSTEM AND GALENA BAY FERRY IN THE WEST KOOTENAY REGION.

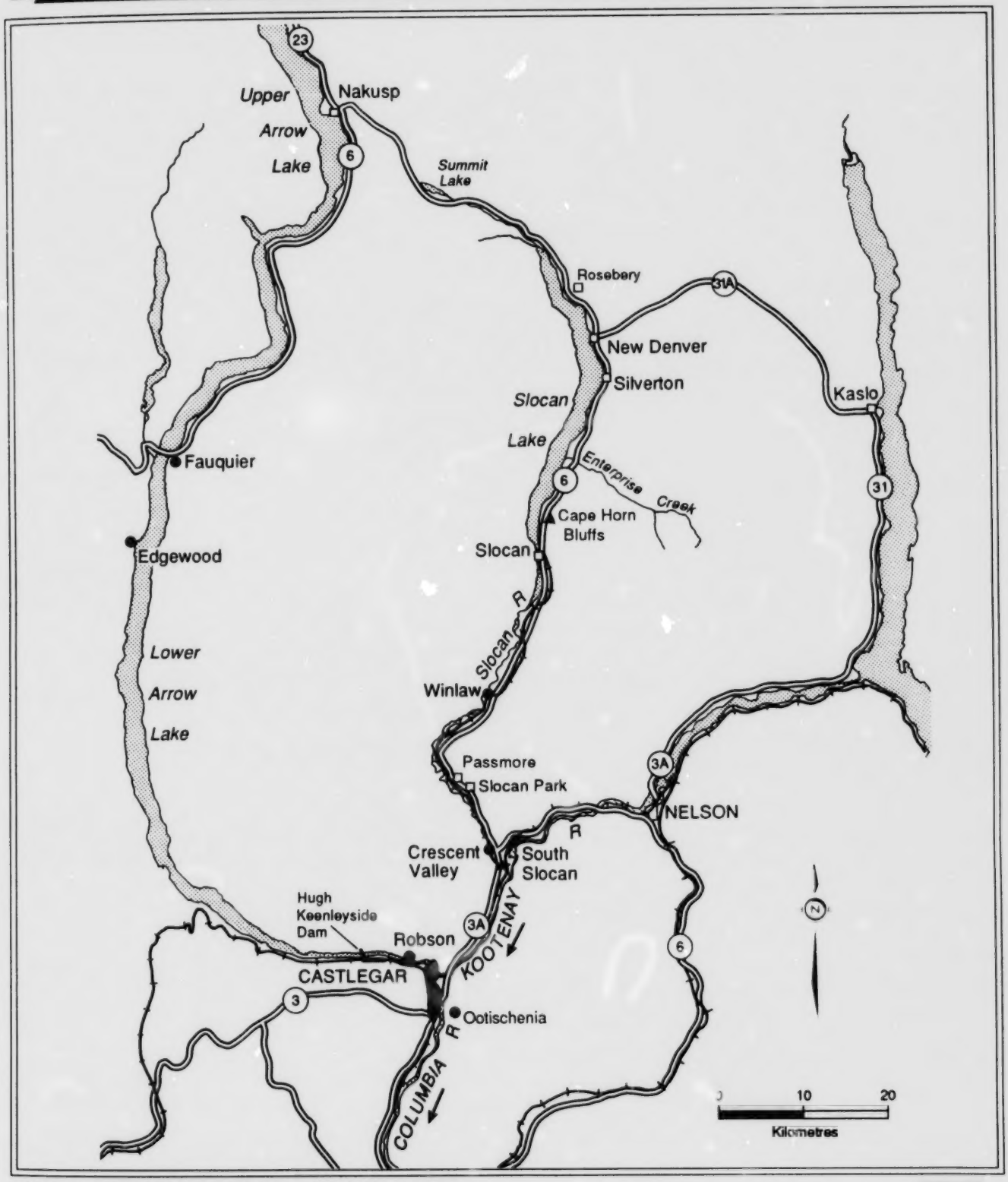


FIGURE 8. HIGHWAYS AND RAILWAYS, CASTLEGAR - NAKUSP.

TABLE 5
ESTIMATED CHANGES IN HIGHWAY TRAFFIC VOLUMES IN SOUTHEAST BRITISH COLUMBIA

Traffic Counter	Location of Counter on a Stretch of Highway	Summer Average Daily Traffic (1988)	Estimated Daily Chip Trucks (1989)	Estimated Incremental Daily Chip Truck Movements (1995)	Estimated Total Chip Truck Movement (1995)	Percent Increase in Traffic Attributable to Incremental Chip Truck Volumes over 1988 S.A.D.T.
37-1	Hwy. 95 - South of Invermere	3,600	0	3	3	0.1
35-4	Hwy. 3 - Cranbrook	12,900	0	10	10	0.1
31-26	Hwy. 3 - East of Salmo	3,000	1	30	1	1.0
32-16	Hwy. 3 - East of Castlegar	1,700	42	30	72	1.8
34-14	Hwy. 23 - South of Galena Bay	770	13	58	71	7.5
34-4	Hwy. 6 - South of Slocan	1,500	51	59	110	3.9
31-2	Hwy. 3A - North of Castlegar	4,200	62	65	12	1.6
32-10	Hwy. 22 - South of Castlegar	4,100	1	1	2	0.0
25-18	Hwy. 97 - North of Kelowna	14,200	0	42	42	0.3
26-11	Hwy. 97 - North of Penticton	15,400	0	0	0	0.0
33-1	Hwy. 33 - North of Jct. with Hwy.3	1,900	0	53	53	2.8
33-3	Hwy. 3 - East of Midway	3,400	22	61	83	1.8
33-10	Hwy. 3 - East of Grand Forks	4,100	37	95	132	2.3
24-9	Hwy. 6 - East of Cherryville	910	0	0	0	0.0

Source: Ministry of Transportation and Highways. S.A.D.T means Summer Average Daily Traffic.

4.2 HIGHWAY SYSTEM IMPACTS

4.2.1 Traffic Volumes

Table 5 displays the data on estimated changes in traffic volumes. Most chips would be transported in B-train trucks. The largest increase in daily chip truck movements involves an additional 95 trucks on Highway 3 east of Grand Forks (Figure 7). Highway 3A would receive an additional 65 trucks and Highway 6 and 23 through the Slocan valley would receive an additional 58-59 trucks per day. The highest increase relative to total traffic volumes occurs on Highway 23 south of Galena Bay where a 7.5% increase in traffic over 1988 volumes attributable to incremental chip truck traffic, is predicted by 1995. On Highway 6 south of Slocan the increase is estimated at 3.9%. The estimated rate of growth in summer average daily traffic is 3% per year on Highway 23 south of Galena Bay, without the Celgar project.[2]

The route subject to the greatest effects of truck traffic is Highway 6 and 23 through the Slocan valley (Figure 8). Table 6 presents specific data based on estimates from the company's Stage II Report and Ministry of Transportation and Highways summer average daily traffic records. On Highway 23, the average number of chip trucks per hour will increase five-fold, with an average of one truck every 15 minutes. The total number of trucks of all types on Highway 23 would approximately double. On Highway 6, the average number of chip trucks per hour will more than double, resulting, on average, in one truck every 10 minutes.

Celgar estimated that total truck kilometers operated would increase by 16.3% as a result of modernization.[3] This is much lower than the increase in total truckloads, since much of the additional volume of wood chips is currently moving by truck and rail to the coast for export offshore. Re-routing truck traffic through the Okanagan and the Rocky Mountain trench, to avoid the Slocan valley, would result in an estimated 41.9% increase in total truck kilometers operated.

The highway transport of incoming wood chips and mill supplies and outgoing pulp is a significant concern to surrounding communities. Castlegar would be the community most directly affected, although construction of a bridge across the Columbia River at Robson would significantly reduce these effects in the downtown area. Communities along Highways 6 and 23 would also experience significant increases in truck traffic.

4.2.2 Ferry Capacity

The M.V. Galena operates between Shelter Bay and Galena

2. Celgar Pulp Company, Stage II Report, Vol. 2, "Fibre Sourcing and Transportation," p. 52.
3. Mr. P. Levelton, Technical Hearings Transcripts, Vol. 2, p. 343.

TABLE 6: EFFECTS OF ADDITIONAL TRUCK TRAFFIC FROM CELGAR PULP MILL EXPANSION ON HIGHWAYS 23 AND 6

	Hwy 23 Galena Bay - Nakusp		Hwy 6 Nakusp - Slocan	
	1988	1995	1988	1995
SADT[a]	770	947	1,500	1,845
Chip trucks/day[b]	13	71	51	110
All trucks/day[c]	85	160	165	250
Chip trucks/hr.[d]	0.7	3.9	2.8	6.1
All trucks/hr.[d]	4.7	8.9	9.2	13.9
Time between chip trucks[e] (minutes)	86	15	21	10
Time between all trucks[e] (minutes)	13	7	7	4

a Summer Average Daily Traffic, Ministry of Transportation and Highways; growth assumed to be 3% per year (1995 does not include incremental chip truck traffic).

b Exhibit V-17/V-18, Volume 2, Stage II Report, Celgar Pulp Co; 3% annual growth rate.

c 11% of SADT is assumed to be heavy trucks based on Ministry of Transportation and Highways ferry statistics, and expanded by 3% per year to 1995.

d An 18-hour day is assumed.

e Trucks/per hour and time between trucks are averages. Time between trucks has been rounded to the nearest minute.

Bay on Upper Arrow Lake. There are 19 sailings per day. The ferry has space for 50 passenger vehicles. Due to weight restrictions a maximum of 4 loaded B-train trucks can be carried, each of which occupy the space of 6 vehicles. Between June - September 1990, a second ferry, the M.V. Shelter (formerly the M.V. Needles), was added to the service. This vessel has space for 26 passenger vehicles, although a maximum of two loaded B-train trucks is permitted, taking the space of 12 passenger vehicles. However, it is unable to keep up to the schedule of the larger and faster M.V. Galena.

Celgar estimated that the proposed project would result in a maximum 36 chip trucks per day in each direction utilizing the ferry system, if all wood chips are moved by truck from Region 1.[4] They argued that the ferries have a capacity of 100-110 commercial trucks per day in each direction which should be sufficient to handle this increase. Other estimates of ferry congestion contradicted this conclusion. The Ministry of Transportation and Highways, for example, suggested that an increase from 6 to 36 chip trucks per day would have a significant effect on the ferry system:

> The effect of an additional 30 (total 36) chip trucks in each direction on the Galena Bay ferry system could be severe. This would utilize up to 9 ferry trips a day with room on these trips for only 10-15 passenger cars. The cyclical nature of logging, timber, and mining industry could also cause a large increase in trucks using these ferries.[5]

The information presented indicates that during summer months and at certain peak times, the Shelter Bay - Galena Bay ferry is often unable to handle existing demand. During the week of July 21-28, 1989, for example, a maximum overflow of 40 vehicles occurred and overflows up to 25 vehicles were common.[6] The projected increases in chip truck traffic would substantially aggravate the ferry capacity problem. Figure 9 shows the current and projected demand in relation to ferry capacity. The 1990 total passenger car units (PCUs) are about 1,100 per day and estimated to increase to 1,222 PCU per day in 1995, at a 3% rate of growth. After construction of the mill, this is estimated to increase to 1,662 PCU/day.

Figure 9 also shows the effect of increasing the number of sailings. The M.V. Galena ferry on a 19 hour schedule is presently unable to accommodate this load; a 24 hour schedule would not resolve this problem after 1995. A 19 hour schedule for the M.V. Galena plus service from the M.V. Shelter would also not significantly improve the capacity problem. A 24 hour M.V. Galena and M.V. Shelter schedule would accommodate projected demand to the year 2001, but there are practical limitations in scheduling ferry travel traffic over a 24 hour period.

The ferry is already beyond capacity at certain times and regardless of Celgar's expanded requirements, traffic forecasts would require the provincial government to invest in ferry upgrades or additions. The proposed upgrade of the M.V. Shelter, involving increased capacity and speed, by the Ministry of Transportation and Highways, is estimated to cost from $2.5 to $3 million. However, even this upgrade alone will be insufficient to accommodate the additional chip truck traffic once Celgar's proposed expansion is complete in 1995.

Recommendation 4

The Panel recommends that additional capacity on the Galena Bay Ferry be provided to accommodate projected growth, as well as additional demand for ferry transportation of chip trucks resulting from Celgar's proposal.

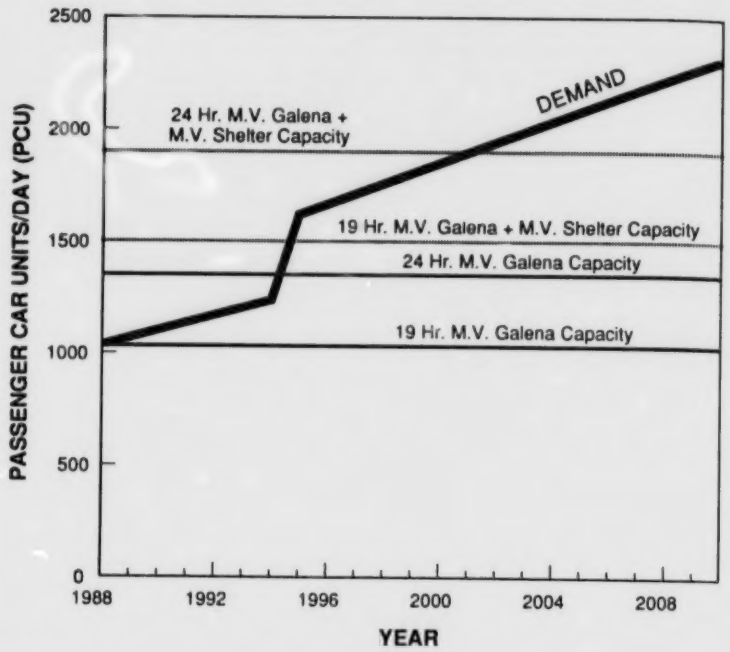
4. Celgar Pulp Company, op. cit., p. 57.
5. Ministry of Transportation and Highways, Technical Hearings Document No. 35, p. 17.
6. Mr. P. Roer, Technical Hearings Document No. 40.

4.2.3 Road Capacity and Deterioration

Of the routes affected, the condition of Highways 6 and 23 was of the greatest concern. An assessment of road conditions on Highways 6 and 23 was undertaken by Celgar. The forecast truck traffic volumes were determined to be within the standard capacity of a two-lane highway. However, it was concluded that the pavement is generally at the end of its useful life and increased traffic will accelerate pavement deterioration. As Celgar's consultant stated:

> The pavement is old, 18 to 23 years. It varies. The life of the highway is beyond its useful capacity, and it is deteriorating. This was confirmed by the falling away deflectometer analysis, which said that the highway was insufficient in bearing capacity for the current legal loads on the highway, and that to improve it would require not only improvements in cross-section, but also improvement in the pavement bearing surface, which would be either pavement overlay or in some cases even an upgrading of the sub-base.[7]

Five sites were identified as not meeting highway standards and upgrading was recommended. The Ministry of Transportation and Highways indicated that six major capital projects and eight rehabilitation projects are proposed. It was generally held by the company and the Ministry that these projects were sufficient to accommodate the forecasted growth in traffic on this route.



Note: Daily PCU ferry capacity is based upon "practical capacity" or the ability of the ferry service to move vehicles with a reasonable ability to meet most peak demand and with an "acceptable" level of service; i.e., a limited amount of queues, time delays and vehicles left behind. When demand exceed capacity, "unacceptable" levels of service occur. The capacity estimates are based upon the highest recorded monthly utilization - 54.6% in July 1988.

FIGURE 9. SHELTER BAY - GALENA BAY FERRY SERVICE DEMAND AND CAPACITY.

Community groups from the Slocan valley, however, argued that the costs of highway upgrading and maintenance attributable to chip truck traffic would be borne by the general public. They suggested that the required road maintenance and upgrading budget in effect provides a subsidy to a single industrial user. Various data were presented on the road maintenance costs of heavy truck and other vehicle traffic. The impact of rail line abandonment on road maintenance costs was also noted. Trucking industry representatives countered that licensing fees and economic benefits more than offset the effects on road maintenance and disputed the estimates of effects suggested by certain community groups.[8]

4.3 Truck Traffic Safety

4.3.1 Vehicle Accident Rates

Celgar presented information on accident rates of chip trucks which indicated that their safety record appears consistent with the overall safety experience for large trucks. Although large trucks are generally involved in more accidents than other vehicles, when distance travelled is factored in, they experience about the same or lower accident rates, according to the research presented. Other findings showed that vehicle type or configuration was much less significant than human and environmental factors in accident occurrence. Data from Ontario corroborate the conclusion that B-trains do not have unusually high accident rates, although the analysis is available for only a short time period.[9] In B. C., heavy vehicles accounted for 2.9% of the total vehicular accidents and 10% of the fatal accidents in 1989.[10]

While the data do not suggest a disproportionate involvement of chip trucks in vehicle accidents in the Slocan valley, residents of the area nevertheless spoke extensively of

7. Mr. D. Mills, Acres Consulting, Technical Hearings Transcripts, Vol. 2, p.350.; "deflectometer analysis" is a process by which the remaining useful life of pavement is measured.
8. Mr. D. Chambers, Chambers Trucking Ltd., Community Hearings Document No. 50.
9. University of Waterloo Institute for Risk Research, "Statistical Analysis of Accident Rates for Large Trucks of Differing Configurations," Paper No. 16, Table 3, November, 1989.
10. Mr. D. Hildebrand, Columbia Pacific Group, Technical Hearings Document No. 28; Technical Hearings Transcripts, Vol. 2, p. 369.

the road hazards, accidents and near-misses which they have experienced. The accident data over the last five years indicate an increase in vehicle accidents, few of which however, directly involved heavy trucks. On Highway 23 from Revelstoke to Nakusp, the total number of accidents increased from 34 in 1985 to 62 in 1989. On Highway 6 from Nakusp to South Slocan (Figure 8), accidents increased from 76 in 1985 to 115 in 1989. In comparison, accidents from South Slocan to Castlegar stayed relatively constant in the 40-50 range per year.

Data from the B.C. Motor Vehicle Branch on vehicle accidents on Highway 6 (1986-1989) showed a total of 484 accidents, 33 or 6.8% of which involved heavy vehicles.[11] Data were also presented showing that cars and light single unit trucks had the greatest absolute accident involvement. There was an average of 12 accidents over each three kilometer interval on Highway 6 during the four year period. An analysis of the distribution of accidents on Highway 6, between Highway 3A at South Slocan and Highway 23 at Nakusp, indicates four areas where the number of accidents per km are more than 50% greater than the average for the entire 124 km section.[12] The four areas (measured from Highway 3A) are: km 0-4 (including Crescent Valley), km 10-14 (including Slocan Park and Passmore), km 74-79 (including Silverton and New Denver), and km 123-124, (approaching Nakusp).

The accident numbers are only those incidents which are reported. Each incident may involve one or more vehicles and an undetermined number of people. An accident caused by a heavy vehicle would only be noted if that heavy vehicle were directly involved.

The Ministry of Transportation and Highways should determine possible remedial measures to reduce the risk of accidents at these locations.

4.3.2 Highway Safety Issues

Residents and professional drivers spoke of the safety-related problems associated with Highway 6 and 23. The key issues referred to were speed limits, road widths, vehicle spacing and passing lanes, and winter driving conditions.

Speed Limits

The Stage II report noted that the 90 km per hr. posted speed limit is believed excessive in many locations and as a matter of course should be reviewed by the Ministry of Transportation and Highways.[13] Consultants to both Celgar and the Panel considered the current speed limit to be excessive.[14] Particular reference was made to the inconsistencies in curve warning signs and encroachments into the oncoming lane due to vehicles maneuvering curves at or near the legal speed limit.

Road Widths

Various community and technical hearing participants commented on the narrow road widths. Residents attested to the hazards for pedestrians and cyclists associated with a lack of shoulders along the highway. The Panel's consultant also stated that inadequate road shoulders were a major deficiency of the current road. In particular, he described the problems on the southern portions of the route:

> From South Slocan through the Winlaw area (about km 30) to beyond km 40 the narrow or non-existent shoulders provide little space for recovery under slippery conditions and little space for escape manoeuvres to avoid animals, both domestic and wild. The posted Maximum Speed of 90 km/h is too high and may mislead some drivers into believing that this is a safe speed.[15]

Vehicle Spacing and Passing Lanes

The lack of passing lanes on many hills and the spacing of chip trucks discharged from the ferry system result in congestion and traffic delays at certain times. Celgar's consultant noted the problem related to trucks leaving the Galena Bay ferry and having to climb a steep grade. The Panel's consultant summarized the concerns:

> The lack of 'safe' passing opportunities due to vertical curves and the lack of climbing/passing lanes may lead to unsafe passing manoeuvres as more capable cars and other vehicles get trapped behind heavily loaded trucks incapable of maintaining speed on sustained upgrades. This problem is aggravated by the tendency for loaded trucks to travel in convoys, in effect doubling or possibly quadrupling the length of vehicles to be passed. Two B-Train Trucks travelling together would be the equivalent of a single 190 ft. vehicle. The ferry service between Shelter Bay and Galena Bay "assembles" these convoys.[16]

Winter Driving Conditions

Residents of the Slocan valley also spoke about the road hazards during winter. Snow, ice and fog add to the difficult conditions. An accident in early 1990 involving a chip truck which narrowly missed a school bus was described. Some participants also suggested that chip trucks have the effect of blowing sand and salt off the roadway.

A variety of related highway safety issues therefore exist on Highways 6 and 23. Most participants, including Celgar's consultants, agreed that the current highway needs significant improvements in order to reduce safety concerns on the route.

4.4 Community Traffic Concerns

4.4.1 Local Traffic and School Bus Operation

Castlegar is predicted to experience the highest increase in chip truck traffic, from 142 trucks per day to 336 trucks per

11. Ibid, p.373.
12. Mr. P. Roer, "Safety and Road Capacity", Technical Hearings Document No. 40, Oct. 11, 1990.
13. Celgar Pulp Company, op cit., p. 53.
14. Mr. P. Roer, Technical Hearings Transcripts, Vol. 2, p. 558; Mr. D. Mills, Technical Hearings Transcripts, Vol. 2, p. 608.
15. Mr. P. Roer, "Safety and Road Capacity", Technical Hearings Document No. 40, Oct. 11, 1990, p.2.
16. Ibid; note: "vertical curves" are changes in the plane of a roadway similar to horizontal curves on their side.

day in 1995.[17] A bypass or alternate route via a bridge at Robson was considered necessary to avoid major traffic congestion on Columbia Avenue. Grand Forks would have an additional 96 trucks per day and Nakusp, Slocan and Greenwood would each increase by around 60 trucks per day. In each case, these are substantial increases over current levels.

The Regional District of Central Kootenay, the Village of New Denver, the Village of Silverton, the West Kootenay School Trustees Association, various community groups and numerous residents expressed their concerns about current and proposed chip truck traffic. Local traffic and highway industrial traffic share the same roadway. This is of special concern for school buses. The following comment is typical of many of the representations:

> My other great concern with chip trucks are school buses. Our narrow winding roads are hazardous in certain weather conditions. School buses stop on the highway and these mega-trucks will have to come to a full stop on ice and slush. This is a steep-sided narrow valley and even the best chip truck drivers cannot keep the huge trailers on their own side of the road at certain corners. Although I have never had the experience of rounding a blind corner to find one jack knifed on the road, some of my friends have. I have seen two trucks on their sides at two different corners. These trucks would destroy our tourist trade in the spring, summer and the fall, and I fear for the safety of our children, especially those travelling by school bus in the winter.[18]

4.4.2 Pedestrians and Cyclists

Residents also described the problems related to a lack of shoulders and paths for pedestrians and cyclists. Reference was made in many presentations to dangerous situations where chip trucks are unable to make room for cyclists when oncoming traffic is passing. Bicycle touring and the need for wider shoulders were also mentioned in relation to community development strategies. One operator commented:

> We are also certain that the kind of business we are going to create will do very well for our community, and that the money which we and our guests will bring will be of far more value for the Valley than all those chip trucks. But with those trucks coming through every few minutes, cycling will be suicidal and I'm afraid that it will be only a matter of time before somebody gets seriously injured, or even killed.
>
> We had some very close encounters on the roads already. And I as an operator will not take this responsibility.
>
> This danger will force us to move our tours back to the Rocky Mountains, where trucks over 4.5 tonnes are eliminated from the roads altogether, and where they have wide shoulders to make cycling safe.[19]

4.4.3 Amenity and Noise Impacts

Increased highway traffic was considered by many participants to conflict with the rural lifestyle of the Slocan valley. As some residents noted, improvements to the highway can also create undesirable aesthetic impacts and encourage additional traffic and noise. The community impacts were summarized by a resident:

> The biggest problem is the transportation route of Highway 6. This situation will be devastating to our municipality and the surrounding areas of Silverton and Hills. These three communities were all built close to the main wagon road that served as the transportation route 80 years ago. Now, in the present, these homes sit very close to the highway, and the 24 hour truck traffic will have an extreme and devastating effect on the lives of these people, on the value of their property and the fastest growing economic industry to the area, which is the retirement and tourism industry.[20]

Surveys by the Regional District of Central Kootenay indicate that residents of the area place a high value on the environmental quality and protection of community watersheds.[21] Tourism and scenic resources are the central focus of community economic development programs.[22]

The compatibility between tourist traffic and industrial traffic was also questioned:

> The Ministry of Tourism wants tourist-related operations. The Ministry of Forests and Highways wants an industrial corridor emphasizing resource extraction. These two things just don't go together.[23]

It is apparent that traffic growth in general, and predicted additional chip truck traffic in particular, will significantly alter the rural character of Highways 6 and 23. Under the current road conditions, local traffic and school bus operations are sometimes incompatible with industrial traffic, especially during poor weather.

Tourism, particularly appealing to the wilderness and touring oriented visitor, suits the values of many of those who live in the region. The growth of industrial traffic in the Slocan valley is resisted by those residents of this still remote and beautiful area of British Columbia.

4.4.4 Vehicle Emissions

Celgar estimated that the vehicle emissions would increase 16.3%, in relation to the increase in annual vehicle kilometers operated by trucks moving woodchips.[24] Additional increases would occur depending on the volume of pulp logs moved by

17. Mr. P. Levelton, Peat Marwick Stevenson and Kellog, Technical Hearings Document No. 26.
18. Ms. J. Taylor, Community School Association, Community Hearings Transcripts Vol. 5, p. 34.
19. Mr. G. Becker, Community Hearings Transcripts, Vol. 3, p. 177.
20. Alderman P. Peterson, Village of New Denver, Community Hearings Transcripts, Vol. 5, p. 24.
21. Regional District of Central Kootenay, "Survey of Resident and Non-Resident Landowners in Electoral Area H", April, 1990.
22. Regional District of Central Kootenay/ Province of B.C., Slocan Valley Development Guidelines, December, 1984.
23. Ms. A. Wright, Coalition for Pulp Mill Accountability, Community Hearings Transcripts, Vol. 5, p. 38.
24. Celgar Pulp Co., op. cit., p. 50.

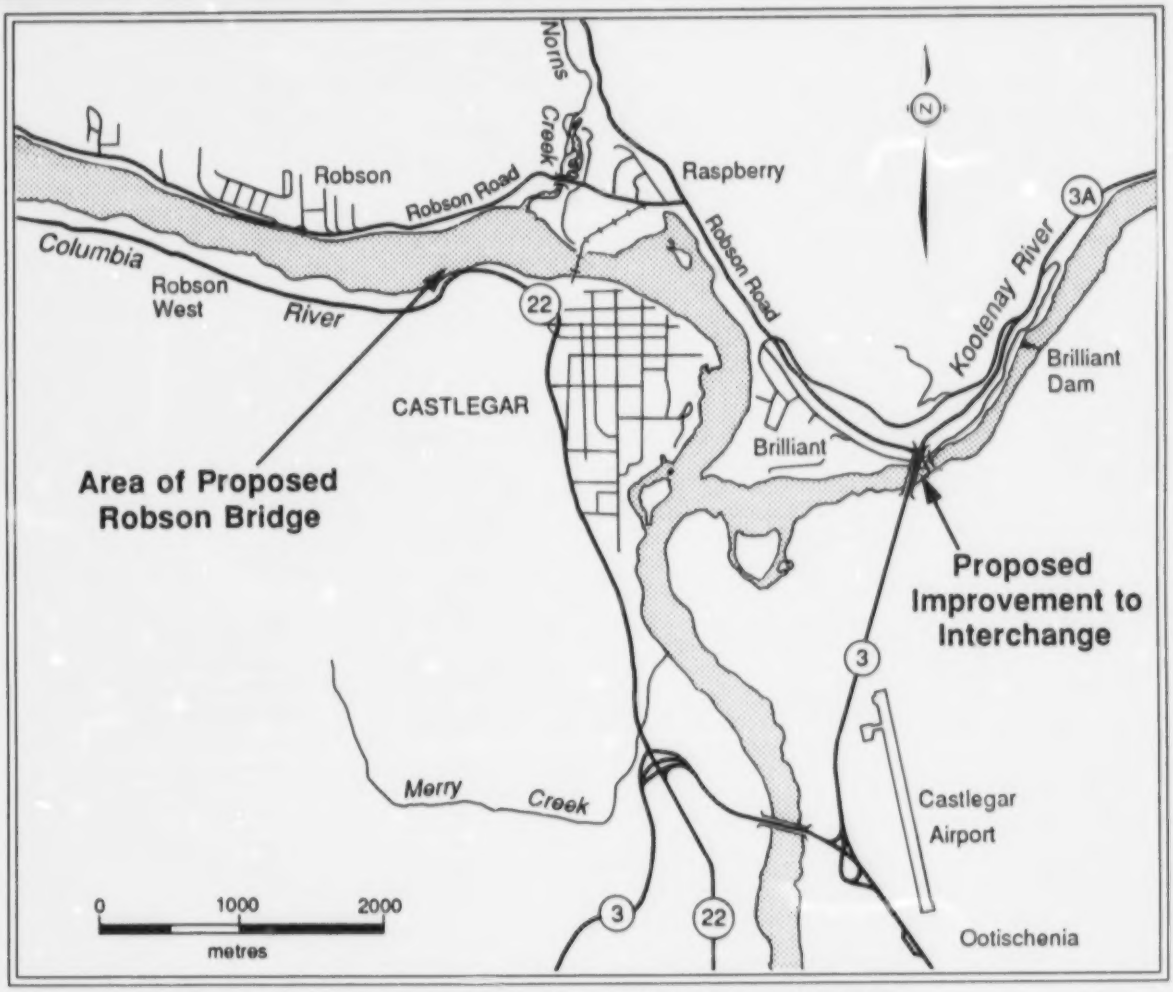
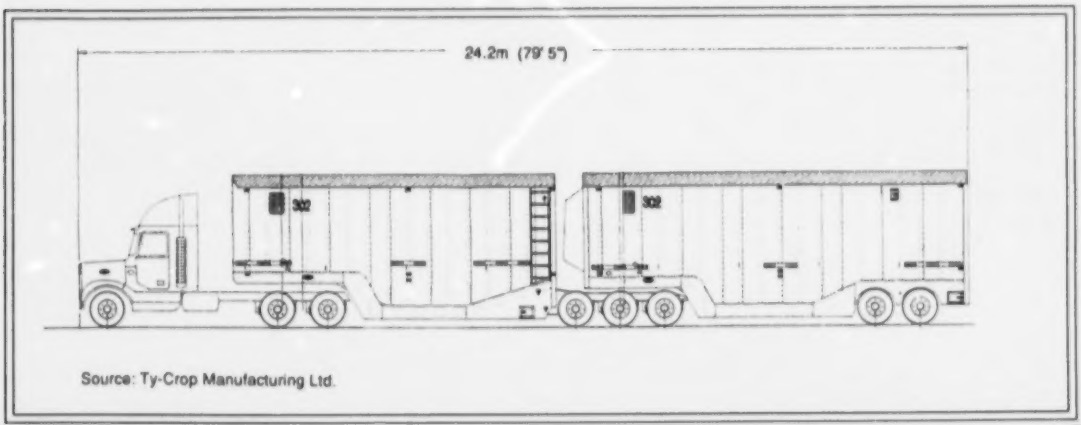


FIGURE 10. PROPOSED ROBSON BRIDGE AND BRILLIANT INTERCHANGE AREA AT CASTLEGAR.



Sideview of B-Train Chip Truck

TABLE 7:
SUMMARY OF BRITISH COLUMBIA MINISTRY OF TRANSPORTATION AND HIGHWAYS CAPITAL AND REHABILITATION PROJECTS IN THE WEST KOOTENAY REGION

(PROPOSED AT THE OCTOBER 19, 1990 TECHNICAL HEARING)

Capital Projects	Estimated Cost ($)		
CPR Crossing at Crescent Valley	75,000	-	100,000
Enterprise Creek	8,000,000	-	10,000,000
Silverton Hill	10,000,000	-	14,000,000
Rosebery Bluff	1,250,000	-	1,300,000
Government Hill (Nakusp)	1,000,000	-	1,500,000
M.V. Shelter at Galena Bay	2,500,000	-	3,000,000
Totals	22,825,000	-	29,900,000

Rehabilitation Projects

Current plans for paving and rehabilitation include the following:

HWY	SECTION	LENGTH (km)	COST ($ millions)	TYPE	ANTICIPATED CONSTRUCTION
3A	Ootischenia to South Slocan	20	2.0	Overlay	1991
6	South Slocan to Slocan City (includes shoulder widening)	45	3.6	Resurface	1995
6	Cape Horn to New Denver	25	2.3	Overlay	1995
6	New Denver to Summit Lake	25	2.3	Overlay	1995
6	Summit Lake to Nakusp (including S-curve reconstruction)	19	3.1	Overlay	1995
23	Nakusp to Half Way River	24	1.7	Overlay	1995
23	Half Way River to Galena Bay	24	1.7	Overlay	1997
23	Shelter Bay to Revelstoke	49	4.4	Overlay	1995
		Total	$21.1		

Source: Ministry Of Transportation and Highways, Nelson, B.C.

truck. Celgar pointed out that some of this increase in emissions would be offset by reduced burning of pulp wood sources in existing logging operations. The air quality and climate change aspects of these emissions are discussed in section 7.7.

4.5 HIGHWAY IMPROVEMENTS TO MITIGATE TRUCK TRAFFIC IMPACTS

4.5.1 Robson Bridge Proposal

The provincial government had committed to construction of a bridge across the Columbia River, upstream of Castlegar (Figure 10). Annual truck loads into the mill have been projected to increase from 18,000 to 42,000 annually.[25] In addition, Westar sawmill and B.C. Hydro are expected to generate increased traffic in the area. The proposed bridge, estimated to cost in the range of $16-21 million (including improvements to the Brilliant intersection on Highway 3), is currently in the preliminary engineering design stage. Five potential sites are under investigation.

4.5.2 Proposed Highway Upgrading

At the hearings, the Ministry of Transportation and Highways identified six capital projects and eight rehabilitation projects proposed for Highways 6 and 23. These are listed on Table 7. The total cost of all of the projects is $44-51 million. Other than Rosebery Bluff, to date none of these have approved funding and scheduling.

Local government and many individuals urged the completion of these projects. Most participants agreed upon the need for such improvements. But many residents are also so opposed to additional truck traffic that they do not consider the substantial highway improvements sufficient to reduce the effects of this traffic.

The Ministry of Transportation and Highways has developed an accelerated pavement rehabilitation program for Celgar's expansion project. The accelerated program would provide additional strengthening of pavement for the majority of the route, at an additional cost of $3.6 million. The proposed

25 . Ministry of Transportation and Highways, Technical Hearings Document No. 35, Oct. 1990, p. 10.

schedule, however, would have a major effect on the regional program, requiring an increase in mean maximum expenditure from $2.5 million per year without Celgar's expansion to $7.1 million per year to accommodate increased use of the highways with expansion.[26]

As stated in the Panel's Interim Report, transportation aspects of the proposal are only acceptable with the provincial government's commitment to the bridge and highway improvements proposed in the Ministry of Transportation and Highways' submission. The provincial government has publicly announced:

> In conjunction with granting the approval-in-principle, and subject to the pulp mill expansion proceeding, the Government of British Columbia has announced a number of highway improvement projects to provide for the safe transport by truck of additional chips to the pulp mill. These improvements include a new bridge over the Columbia River and intersection upgrading to divert chip truck traffic from the centre of Castlegar, and improvements to Highways 3A, 6 and 23.
>
> Preliminary site studies for the new bridge have been completed and will be the subject of public meetings in Castlegar to determine the best location.[27]

This announcement removed the precondition of the Panel's recommendation of approval in principle for the project.

While these projects appear to respond to particular problems regarding Highways 6 and 23 raised at the hearings, the Panel believes that the annual review of the Regional Transportation Plan should reassess the adequacy of the capital projects, in view of usage of this route. Further, the locations on Highway 6 with the greatest frequency of accidents should be reviewed before highway construction projects are finally committed, to determine whether additional remedial measures are necessary.

4.5.3 Traffic Management

The Panel heard concerns about the timing and spacing of chip trucks along Highways 6 and 23. The ferry system affects the flow of trucks and suggestions were discussed as to the ability to control the movement of trucks so they do not arrive and depart from the ferry in convoy. The Ministry of Transportation and Highways, for example, noted the possibility of some radio communication arrangement to manage the flow of trucks.[28] Industry has requested extension of the ferry service to shift more truck traffic to off hours.[29] The Ministry of Transportation and Highways noted that this is limited by the operating hours of weigh scales and mill yards.

The Panel considers the impact of increased wood chip traffic, given the condition and usage of Highways 6 and 23, to be unacceptable. The Panel's Interim Report confirmed that substantial measures to manage traffic would be necessary.

Recommendation 5

The Panel recommends that traffic safety measures on Highways 6 and 23 be introduced:

- ***to control the movement of trucks so as to avoid their arrival and departure from the Galena Bay Ferry in convoy;***
- ***to reduce the speed limit for all vehicles from the current 90 kph; and***
- ***to restrict the traffic of heavy trucks during hours when school buses pick up and deliver children.***

4.6 Options to Avoid Truck Traffic Impacts

The proposed highway improvement projects are essential to redressing the traffic and safety concerns on Highways 6 and 23, with or without the Celgar project. The effect of mill expansion would be to advance the scheduling of these projects, as well as the proposed Robson bridge. The British Columbia government's implementation of the Panel's highway, ferry capacity, and traffic management recommendations would mitigate the impact of increased trucking of wood chips on Highways 6 and 23 to an acceptable degree.

However, the Panel finds that attractive alternatives were presented which would avoid these impacts. Given the considerable cost of implementing the highway and traffic improvement terms and conditions required to make the proposal acceptable to the Panel ($60 to 72 million in proposed highway system improvements alone), it would be important to concurrently consider alternatives which would divert wood chip transportation from the Slocan valley. This becomes even more important, since it is around the issue of increased truck transportation on this route that the clash of values is most difficult to reconcile among communities affected by Celgar's proposal.

4.6.1 Wood Chip Transportation Alternatives

Celgar was requested in the Terms of Reference for the Stage II Report pursuant to the Major Project Review Process, to undertake an evaluation of transportation options. This study was requested as a result of the concerns related to potential impacts of proposed truck traffic associated with an expanded mill. The development of alternative modes (barge and railway) were identified as a potential means of eliminating or reducing the effects of additional truck transportation.

Celgar identified and evaluated eleven wood chip transportation options (Table 8). The Stage II Report summarized these options in relation to the wood supply regions (Figure 3).

Celgar's financial comparison of these options included estimates of infrastructure and terminal operating costs. Their analysis indicated that trucking using the shortest possible routes (Option No.1) was the most financially

26. Ministry of Transportation and Highways, Technical Hearings Document No. 35 (Supplement), p. 3.

27. B.C. Ministry of Regional and Economic Development, News Release, "Celgar Granted Approval-In-Principle for Pulp Mill Expansion," December 20, 1990.

28. Ministry of Transportation and Highways, op. cit., p.16.

29. Mr. D. Chambers, Chambers Trucking Ltd., op. cit.

TABLE 8
SUMMARY OF WOOD CHIP TRANSPORTATION OPTIONS

Option		Description of Transportation Options by Chip Supply Region	Cost/year ($million)
1	Truck	best routing in all regions	18.05
2	Truck	alternate routes to Hwy. 6/23	22.15
3	Truck/Rail	truck in regions 2,6; rail in region 1	22.53
4	Truck/Rail	truck in regions 1,3,4,5,6; rail in region 2	20.99
5	Truck/Rail	truck in regions 1,2,4,6; rail in region 5; truck/rail in region 3	22.20
6	Truck/Rail	truck in regions 3-6; rail in regions 1,2	22.57
7	Truck/Rail	truck in regions 2,4,6; rail in regions 1,5; truck/rail in region 3	28.36
8	Truck/Rail	truck in regions 1,4,6; rail in regions 2,5; truck/rail in region 3	22.23
9	Rail/Truck	rail in regions 1,2,5; truck in regions 4,6; truck/rail in region 3	28.41
10	Truck/Barge	truck in regions 2-6; barge in region 1	22.50
11	Truck/Barge	truck in regions 2-5; barge in regions 1,6.	25.51

Source: Celgar Pulp Company, Stage II Report, Vol. 2, p. 27.

attractive alternative with an annual cost of $18 million. The next best option, Option No.4, involving rail transport from Region 2 was estimated to cost another $3 million annually. The options were estimated at an additional cost ranging from $3 million to $10 million annually over Option No.1.

With the exception of truck transportation, in which case the company does not directly bear the cost of construction and maintenance of the highways, Celgar's analysis assumed that the company would need to provide for both capital and operating costs of barge and rail options. This included loading and unloading facilities. Their costs were also assumed to reflect capital costs of transportation equipment, either directly or through rates quoted by commercial carriers. Celgar's comparison, of necessity, reflects the fact that rail, truck and barge operating companies price their freight rates on different bases, and that rail rates are generally higher than truck rates. However, Celgar's transportation consultant also noted that, "while barge rates are lower than truck rates, the extra handling of the wood chips decreases the rate differential to a point where total barge costs excluding capital are just slightly less than for trucking".[30]

The feasibility of these transportation options and the public costs for highway infrastructure directly associated with the proposed project were a major focus of discussion at the Community and Technical Hearings. Many participants noted that no consideration was given to the capital, operating and maintenance costs of public infrastructure. However, no reliable data were provided on the incremental public infrastructure costs attributable to the proposal. In their brief to the Panel, the Ministry of Transportation and Highways stated:

> To date neither Celgar nor the Ministry has been able to develop a comprehensive estimate of overall capital, operating and maintenance costs of public infrastructure associated with each of the transportation options presented in the Stage II Report... The only projects that would be considered primarily for the benefit of the pulp mill are the proposed new bridge across the Columbia River and the improvement to the Brilliant Intersection for an estimated cost of $21,000,000. Such a bridge would benefit not only the pulp mill, but also the residents of the area. It may well be argued that the cost would be mitigated by the economic benefits of pulpmill expansion, and the increase in tax revenues to the Province and the City of Castlegar.[31]

The Ministry recognized, along with other participants, that public infrastructure costs are an important element which should be considered in the comparison of transportation options. This was especially emphasized by members of the Slocan Valley Watershed Alliance who argued that the trucking options involve subsidized public infrastructure:

> Transportation of fibre to Celgar in the form of logs and chips will result in more than doubling chip traffic and logging truck traffic in the Slocan valley. This poses unacceptable public safety problems, and is subsidized by taxpayers through road upgrades and frequent road repairs.... If a subsidy must occur, let it be for rail and barge transport of pulp logs and chips. Subsidies for never-ending highway changes and repairs dictated by private industry are unacceptable.[32]

Dr. Heaver, representing the Kootenay Coalition for an EARP, also indicated that transportation options need to be considered within a social benefit-cost framework:

> The efficient use of transportation to serve the Celgar mill and community interests, requires that investment in alternative modes be considered. Public costs in providing support to the transportation system required by Celgar and the communities of the region, may well be minimized by public investment in infrastructure for barge and possibly, rail services. One approach is to start with the estimated expenditure required to provide highway infrastructure, and to examine the effectiveness of alternative uses of such capital.[33]

Celgar's consultant noted the difficulties in attributing

30. Mr. P. Levelton, Peat, Marwick, Stevenson, Kellogg, Technical Hearings Transcripts, Vol. 2, p. 341-342.
31. Ministry of Transportation and Highways, op. cit., p. 15-16.
32. Mr. R. Lerch, Slocan Valley Watershed Alliance, Technical Hearings Transcripts, Vol. 2, p. 444-445.
33. Dr. T. Heaver, Technical Hearings Document No. 30, p.2.

infrastructure costs to any one user, or identifying the ultimate beneficiaries of infrastructure particularly when investment decisions are related to regional economic development policies and overall community objectives.

4.6.2 Regional Transportation Plan

The issue of transportation alternatives which could avoid or reduce the impact of proposed truck traffic can only be considered within the context of transportation planning in the region. Federal and provincial policy regarding transportation development establishes the framework for managing traffic generated by the Celgar project as well as other users.

The choice for truck transport reflects the short-haul and dispersed sources of the wood chip suppliers. But it also reflects a less well developed rail and barge infrastructure currently existing in the region. Given the available information, the rail and barge options for transporting wood chips cannot be dismissed as uneconomic from a public policy perspective. The data submitted by Celgar, including confidential rate information, were insufficient to fully verify the results of the financial analysis.

Participants advocated consideration of a broader range of transportation policy factors in the development of regional infrastructure. For example, there appears to be substantial and increasing demand for north-south transportation links between Revelstoke and Castlegar. These and other opportunities may well exist to provide a basis for increased industrial traffic, such as Celgar's chip truck traffic, to support development of road, rail and barge alternatives in the region.

Representation to the Panel referred to proposals from representatives of Slocan valley communities to transportation planning bodies for a road between Robson and Fauquier which would divert industrial traffic from Highway 6. With respect to alternative routes, Celgar is on record as supporting the development of a north-south link along the Arrow Lakes that would bypass the Slocan valley.[34]

Participants argued that federal policy decisions appear to discount rail transportation as they review rail abandonment decisions. The provincial government stated a preference for rail shipment of wood chips on certain routes. However, the provincial government's regional transportation plans for the Kootenays reflect high priority for highway systems.

The Ministry of Transportation and Highways provided information on the Kootenay Region Transportation Task Force, which, as part of the provincial government's "Freedom to Move" program, undertook a public review of transportation policies and plans in the region.[35] A series of public meetings were held in April, 1989 to receive suggestions for a transportation plan. Various concerns and priorities were identified which are relevant to the Celgar proposal, including:

- construction of a bridge across the Columbia River near Castlegar;
- Highway 6, Slocan Bluffs reconstruction;
- Highway 6, Rosebery Hills reconstruction;
- Highway 6/3A to Nakusp upgrading;
- Arrow Lakes ferry service and fixed link;
- Robson - Fauquier Highway 23 extension;
- railway abandonment.

Many of these issues were discussed by participants at the Community and Technical Hearings. The Ministry of Transportation and Highways described their transportation planning activities in addressing the priorities selected by the Task Force. Portions of these activities would be accelerated by the Celgar project.

The development of a regional transportation system is a matter of public policy which extends beyond the issues related to the Celgar mill. Celgar was requested by the provincial government to evaluate alternative modes of transporting wood chips and their financial analysis indicated a preference for the trucking option. Other options in which the company is required to more directly bear the burden of new infrastructure costs proved to be less economic to Celgar.

Further consultation of the transportation alternatives could provide an important impetus for the evolving transportation plan. So far, there is no means of determining the economic impact of wood chip transportation alternatives, other than on the basis of private costs to Celgar. However, regional transportation planning should continue from the base of the 1989 Task Force.

Recommendation 6

The Panel recommends that the British Columbia Ministry of Transportation and Highways and the Regional District of Central Kootenay develop a transportation plan for the Slocan valley.

4.6.3 Road Options

The Ministry of Transportation and Highways also indicated that the concept of a north-south link along Arrow Lakes connecting Castlegar to Fauquier is proposed for feasibility study in 1991.[36] This route, also known as the Highway 23 extension, was first considered in the 1960s. A version of this proposal involving an industrial road with lower design standards and costs was also suggested.[37] Considerable local support was expressed for this alternative industrial road.

The Panel also requested information on the potential for an industrial road along an abandoned rail right of way. The Ministry of Transportation and Highways suggested that engineering and cost factors, such as the limited width of the railbed, the many tunnels and bridges, and the heavy snowfall and maintenance costs, made this concept unfeasible.

A network of logging roads exists throughout the area on the east side of Arrow Lakes. British Columbia's resource industries depend to a considerable degree on maintenance and operation of resource roads, often single lane with radio control. Given the potential roadbeds and the network of

34 . Mr. P. Levelton, Technical Hearings Transcripts, Vol. 2. p. 345.

35 . Ministry of Transportation and Highways, Kootenay Region Transportation Task Force Report, 1989.

36 . Ministry of Transportation and Highways, Technical Hearings Transcripts Vol. 2, p. 493.

37 . Mr. R. Barkley, Regional District of Central Kootenay, Technical Hearings Document No. 48.

private roads in existence in the region, there may be an alternative of diverting wood chips from Highways 6 and 23 to private roads.

4.6.4 Rail Options

Public groups such as the Kootenay Coalition for an EARP, the Coalition for Pulp Mill Accountability and others urged consideration of rail transportation (Figure 11). They pointed out that the Province of British Columbia intervened in the application before the National Transportation Agency (NTA) by CP Rail to abandon the Boundary subdivision between Midway and Robson on the grounds that there may be potential for a viable short-line operation and the line may offer a means of mitigating incremental road maintenance and capital costs associated with mill expansion.[38]

In their submission to the National Transportation Agency, the Ministry of Transportation and Highways stated:

> ...the Province estimates that the Celgar expansion could generate an equivalent volume of up to 8,300 truckloads per annum of wood chips originating at Midway and Grand Forks, inclusive. The Government of British Columbia is cognizant of the losses incurred by CP Rail in operating this portion of the line, however in light of this potentially new traffic the Province submits that the Agency assess the probability of the line segment becoming economic in the future.[39]

At the request of the Panel, representatives from Transport Canada provided background information on the NTA decision to approve the abandonment except for the Grand Forks segment. Actual losses in recent years have totalled $1.1 million annually and the probability of attaining even the lower estimate of 3,600 carloads of wood chips as traffic on the branch line was considered uncertain.[40] The Grand Forks segment of the line was considered currently uneconomic but having the potential to be economic. The Agency indicated it would review their decision on this segment after a one-year period.

Celgar undertook financial analysis of seven rail transportation options. These options incurred annual costs in the range of $21-28 million, some 16-57% higher than the least cost trucking option. The costs of dumper facilities and equipment leasing in particular make this option financially unattractive.

Boundary Transportation presented extensive briefs at both community and technical hearings. Their submissions questioned the capital costs and revenues adopted in Celgar's assessment of the rail options. They suggest that a comprehensive restructuring of costs, including changes to provincial property taxes and federal depreciation rates, could provide for profitable short and intermediate haul operation. Other participants suggested that there are distortions in the accounting of costs in abandonment decisions.[41]

Boundary Transportation recommended that the provincial government become actively involved in resurrecting rail service on the Boundary Subdivision by determining the long-term serviceability of the line, purchasing the line for its net liquid value, adjusting provincial tax revenues to make the service viable and finally, leasing the line to a private operator.

The Panel's consultant, Mr. Partington, indicated that short-haul wood chip movements are a good fit for the trucking industry and are not for the rail mode. He indicated that, from a private financial perspective alone, revenue from rail transport of wood chips is probably insufficient to contribute to replacement and maintenance of their fleet.

4.6.5 Barge Options

Celgar considered the feasibility of barge transport of wood chips down the Arrow Lakes. Cost estimates were prepared for barge terminals at Shelter Bay and Needles (Figure 7), unloading facilities at the mill, and barging services. It was assumed that all wood chips from Regions 1 (Trans-Canada Highway) and 6 (Okanagan) totalling 785,000 m^3 would be moved by barge.

The company suggested that three problems were associated with this option. First, fluctuating water levels in Arrow Lakes make operation of the terminals difficult. Second, ice in the lakes can apparently limit vessel operation, although this was also disputed by a Transport Canada representative, and Celgar's capacity to manage several week's inventory on-site might accommodate short interruptions in barge traffic. Third, rehandling of wood chips was estimated to result in a fibre loss of up to 3%.[42]

Celgar's financial analysis indicated that the barge options would cost $22.5 - $25.5 million annually, some 25-40% higher than the lowest cost trucking option. The costs of constructing the terminal facilities were the principal reasons for the higher costs of this option. Again, the cost disadvantage to Celgar was based on their assuming full capital and operating costs of barge handling infrastructure.

The Ministry of Transportation and Highways supported the hauling of chips by barge, but acknowledged the technical and cost constraints. Various interest groups and individuals advocated barging as an alternative to trucking through the Slocan valley.

4.6.6 Conclusions Regarding Transportation Alternatives

The Panel believes that there is a real opportunity to reopen proposals favoured by the community in the work of the 1989 Kootenay Regional Transportation Task Force. At the same time, impacts of the increased wood chip traffic on the Slocan valley could be avoided, with the possibility of lower costs to Celgar and the public than the financial implications of Celgar's truck transportation proposal (public costs of $60 to 72 million in proposed highway system improvements alone).

Before final design and construction of highway improvements are committed, it would be desirable to charge a task force with consideration of public and private costs and

38. B.C. Ministry of Transportation and Highways, Submission to the NTA of Canada in the Matter of an Application by CPR Ltd...to Abandon a Portion of the CP Rail Boundary Subdivision between Robson West and Midway in the Province of B.C., May 18, 1990, p. 2.
39. B.C. Ministry of Transportation and Highways, op. cit., p.5.
40. National Transportation Agency, Decision No. 484-R-1990, Sept. 10, 1990.
41. Dr. T. Heaver,Technical Hearings Transcripts, Vol. 2, pp.393-395.
42. Celgar Pulp Company, op. cit., p. 21.

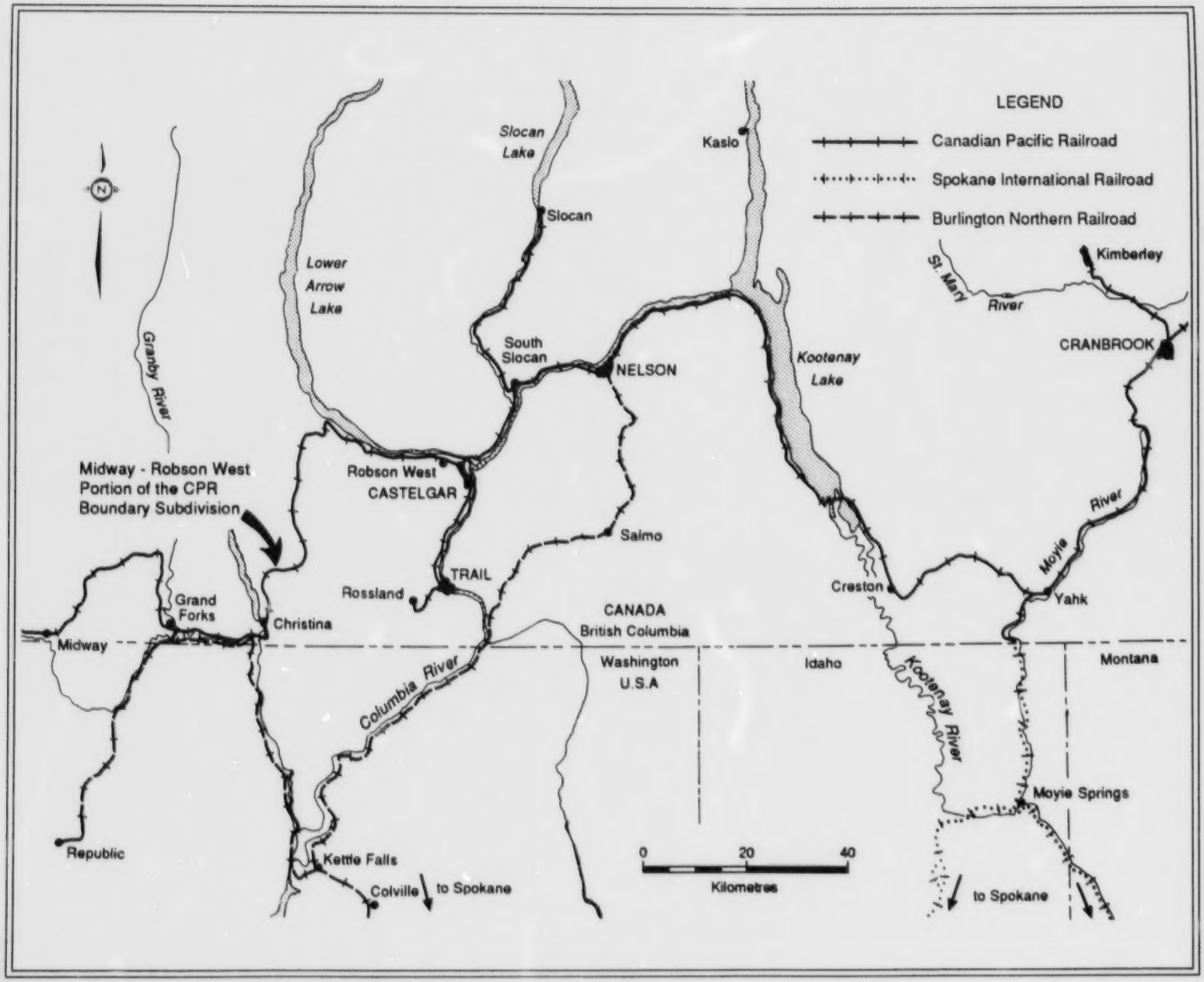


FIGURE 11. RAILWAY NETWORK IN THE WEST KOOTENAY REGION.

B-Train Chip Truck

benefits of barge, rail and private and public road alternatives in comparison with the truck transportation alternative proposed by Celgar. This task force could involve or consult with a broad range of interests: representatives of Celgar; communities affected; current or potential barge, rail and trucking interests; and representatives of transportation authorities of local, provincial and federal governments. A report later in 1991 would allow Celgar and the provincial government to reassess the desirability of the trucking proposal, with an informed analysis of alternatives which could be implemented to coincide with the expanded mill's increased demand for wood chips.

This approach would reinforce the Ministry of Transportation and Highways' recently adopted policy of subjecting major capital investments to a cost-benefit analysis.

Recommendation 7

The Panel's attention was focused on the impact of truck transportation as proposed by Celgar, and the provincial government has made a public commitment to accept the Panel's recommendation for road transportation improvements. In parallel, the Panel also recommends, as a follow-up to the 1989 Kootenay Region Transportation Task Force Report, that alternatives to avoid the impact and costs associated with mitigation of increased trucking of wood chips on Highway 6 and 23 be considered by a task force, which would undertake a study of the public and private costs and benefits of barge, rail, and private and public road alternatives in comparison with the truck transportation alternative proposed by Celgar.

CHAPTER 5: PULP MILL PROCESS ISSUES

5.1 PROCESS DESIGN

5.1.1 General Description of Process Changes

The Celgar pulp mill started production in 1960 utilizing technology typical of the 1950s. Design capacity was 454 ADt/d from a mixture of southern British Columbia softwoods.

Wood chips for the process were produced in an adjacent woodroom using mainly water-transported logs from Tree Farm Licence 23. Kraft pulping was followed by five stages of bleaching consisting of chlorination [C], caustic extraction [E], chlorine dioxide addition [D], caustic extraction [E], and chlorine dioxide addition [D]; (the whole process abbreviated to CEDED). Waste pulping liquor was processed through a conventional kraft recovery system (producing steam) and waste wood by incineration in a power boiler system (also producing steam). Steam was used to produce some power. Effluent from the mill including that from bleaching was discharged to the Columbia River without secondary treatment.

Modifications to the mill since start-up have been minor. Production levels have been increased to 560 ADt/d. Over the years chipping of logs at the mill has been totally replaced by purchasing chips produced from waste wood at sawmills. The old woodroom clarifier collects fibre losses from the pulp mill. A major reduction in fibre loss to the river has been achieved. Pulping is still carried out in two Kamyr continuous digesters. Celgar was a pioneer in the substitution of chlorine dioxide (ClO_2) for elemental chlorine (Cl_2) in the first stage of bleaching (designated as D_C) and currently uses 20-40% in that stage. The mill has also adopted the use of oxygen in the first extraction stage (designated as E_O), and has improved mixing of chemicals with pulp. The sequence is thus D_CE_ODED. These process changes gave some economic and environmental benefits. Costly attempts to improve recovery boiler operation were unsuccessful. The present mill's effluents and air emissions do not meet current and anticipated environmental standards.

The expansion and modernization involves replacement of almost all the existing mill with new equipment. A diagrammatic process flow is shown in Figure 12. Some 10% of the chip supply will be produced by reopening the wood room but with equipment designed to eliminate the high fibre loss in the effluent characteristic of the original mill. The remaining 90% will be sawmill chips (areas 1-6, Figure 12). The fibre line where chips are converted into pulp and where the brown pulp is bleached to high brightness would be totally new (areas 7-17, Figure 12). The process is designed to improve effluent characteristics and to minimize emissions. The effectiveness of the process in reducing organochlorines (Figure 13) is discussed in section 5.1.3.

Kraft pulping is achieved by the Kamyr MCC process (modified continuous cooking) which reduces bleaching requirement by taking out more lignin than did the old mill. An additional processing stage is to be introduced in the form of the proposed oxygen delignification stage which further reduces lignin content. The new bleached fibre line will use the sequence $D_CE_{OP}DD$, where the main changes are the ability to achieve 100% ClO_2 substitution in D_C, the use of peroxide and oxygen in the extraction stage (E_{OP}), improved effluent, emissions, mixing and washing, better control of spills and a cleaner employee environment.

The new chemical recovery process (areas 26-30, Figure 12) will contain major improvements in technology for emission control. Changes in the steam and power systems will allow the mill to be 90% energy self-sufficient compared with 11% for the existing operation. Of major significance is the effluent treatment system consisting of primary and secondary treatment and a spill pond to handle in-plant spills (areas 34-41, Figure 12).

5.1.2 Best Available Control Technology

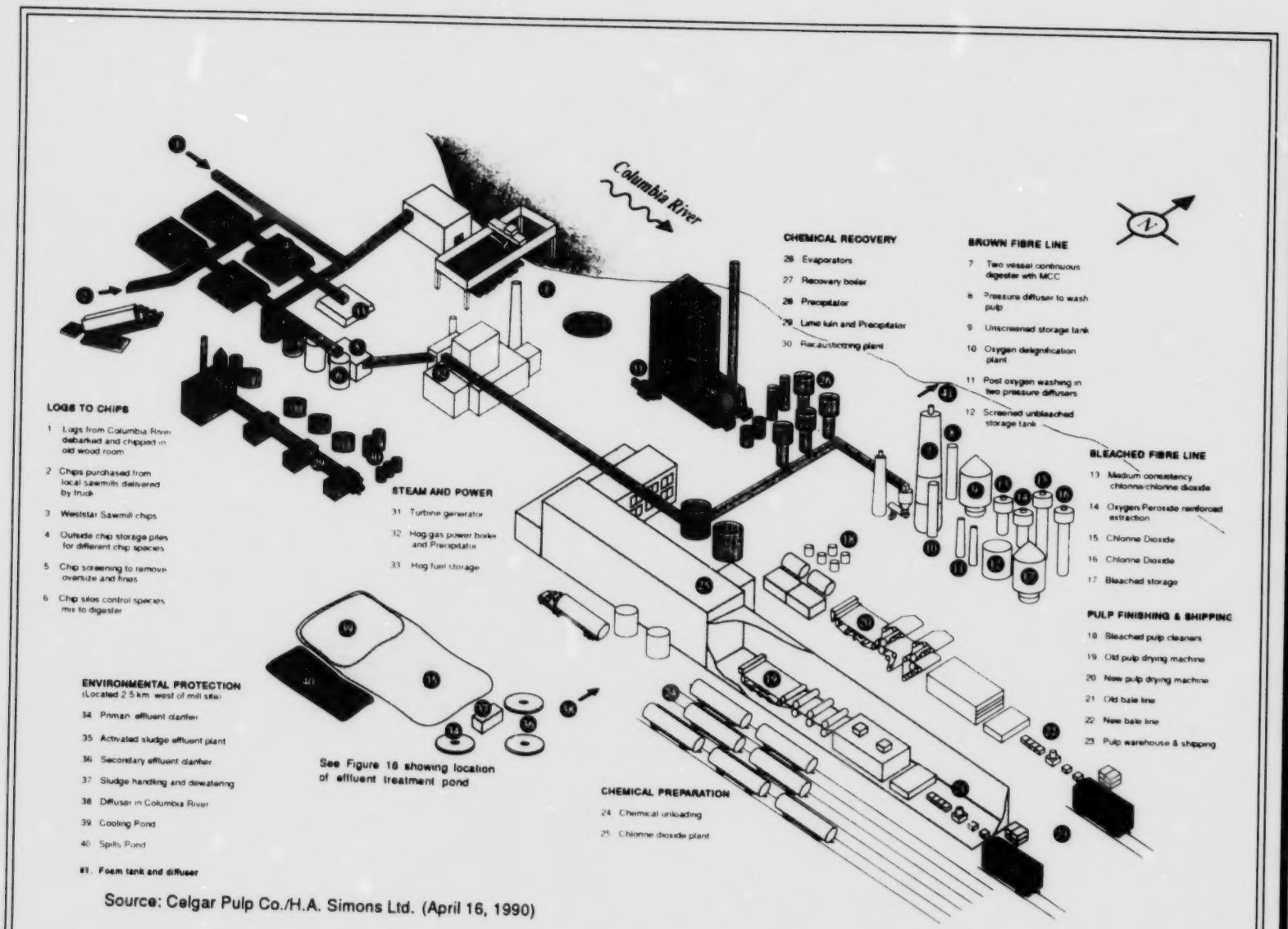
Celgar described the process features which have been proposed to minimize the environmental effects of mill expansion. They stated that the design addressed four key items:

- to provide state of the art technology by 1990's standards;
- to incorporate the best available technology;
- to ensure that all environmental requirements are met; and
- to provide the flexibility to make future changes for environmental improvements.

The environmental standards for mill expansion were constrained by the type of pulp which the company proposes to produce. Celgar and their customer representative stated that the new mill must meet the same high quality market pulp standards as the present mill, characterized by high strength and high brightness.

Estimates of air and water contaminant loadings in the project Prospectus were based upon the requirements of the Level A Pollution Control Objectives of the Ministry of Environment. These estimates were substantially revised in the Stage II Report based on the adoption of best available technology and more precise information on the actual performance of mill equipment. Celgar stated:

> The proposed mill will incorporate all of the major technological advancements that have taken place in the past decade or so in kraft pulping and which have been proven commercially successful. These include modified continuous cooking (MCC); medium consistency single-stage oxygen delignification; pressure diffusion washing in the brown fibre line; atmospheric diffusion washing in the bleach plant; high (70%) chlorine dioxide substitution (with sufficient ClO_2 generating capacity provided to go to 100%); pressurized caustic extraction reinforced with oxygen and hydrogen peroxide; condensate stripping and high black liquor solids firing in the recovery boiler. All of these advancements have been made to reduce the emissions from the mill. To our


Columbia River
LOGS TO CHIPS
1 Logs from Columbia River debarked and chipped in old wood room
2 Chips purchased from local sawmills delivered by truck
3 Weststar Sawmill chips
4 Outside chip storage piles for different chip species
5 Chip screening to remove oversize and fines
6 Chip silos control species mix to digester
STEAM AND POWER
31 Turbine generator
32 Hog gas power boiler and Precipitator
33 Hog fuel storage
CHEMICAL RECOVERY
26 Evaporators
27 Recovery boiler
28 Precipitator
29 Lime kiln and Precipitator
30 Recausticizing plant
BROWN FIBRE LINE
7 Two vessel continuous digester with MCC
8 Pressure diffuser to wash pulp
9 Unscreened storage tank
10 Oxygen delignification plant
11 Post oxygen washing in two pressure diffusers
12 Screened unbleached storage tank
BLEACHED FIBRE LINE
13 Medium consistency chlorine/chlorine dioxide
14 Oxygen/Peroxide reinforced extraction
15 Chlorine Dioxide
16 Chlorine Dioxide
17 Bleached storage
PULP FINISHING & SHIPPING
18 Bleached pulp cleaners
19 Old pulp drying machine
20 New pulp drying machine
21 Old bale line
22 New bale line
23 Pulp warehouse & shipping
ENVIRONMENTAL PROTECTION
(Located 2.5 km west of mill site)
34 Primary effluent clarifier
35 Activated sludge effluent plant
36 Secondary effluent clarifier
37 Sludge handling and dewatering
38 Diffuser in Columbia River
39 Cooling Pond
40 Spills Pond
41 Foam tank and diffuser
See Figure 18 showing location of effluent treatment pond
CHEMICAL PREPARATION
24 Chemical unloading
25 Chlorine dioxide plant

Source: Celgar Pulp Co./H.A. Simons Ltd. (April 16, 1990)

FIGURE 12. CELGAR PULP MILL DIAGRAM OF PROCESS FLOW.

knowledge, there are no proven technological developments that could have been included in this mill to further reduce its emissions.[1]

The Ministry of Environment defines "best available control technology" (BACT) as:

> Currently available, state-of-the-art control technology which is proven and has been successfully applied for at least one year in similar facilities in the Province or in other jurisdictions, and which is reasonably cost effective as determined by the Ministry.[2]

The Ministry indicated that if the mill expansion is approved, they would amend the existing permits based on this concept. They noted that the company has agreed to this approach, and that the BACT approach would result in predicted waste discharge levels and stack emissions below current objectives or proposed regulations.[3] With specific reference to air emissions, the Ministry carried out an independent evaluation of BACT as it applies to kraft mills and accepted Celgar's proposal as being BACT according to their definition.[4]

The federal Department of Fisheries and Oceans and Department of the Environment also expressed satisfaction with the technological standards adopted in the Celgar proposal. They stated that the proposed equipment in the pulping and bleaching process has a proven record of operation in performing to specifications.[5]

A comparison was provided of Celgar's proposal with pulp mills currently being designed and built in Sweden.[6] It was concluded that the design concept of the Celgar proposal has been carried out according to the latest process technology. A few exceptions were noted from the latest Swedish technology, particularly the lack of an additional open washing stage after the oxygen delignification stage which further reduces the discharge of chlorinated organic compounds. However, it was pointed out during the hearings that the proposed washing system would more than offset this through a process with the equivalence of almost four drum stages of washing.[7] The quality of projected effluent discharges would also be in the same order as for current Swedish mills.

Information was presented to the Panel indicating that the main items of the proposed technology are well proven in commercial operation. For example, the process designers state that in terms of major equipment, there were 16 MCC systems, 21 MC Kamyr oxygen delignification systems and 14 Gotaverken low odour recovery boilers in operation.[8]

Other process designs, including the use of ozone, nitrogen dioxide and two-stage oxygen delignification, which might further reduce organochlorines were suggested by the Pulp, Paper and Woodworkers Union and the Kootenay Coalition for an EARP. However, the technology is developmental and the Panel found no information showing that these recent developments have a proven performance record in the production of market pulp.

The operation of the new mill will be assisted by the use of a distributed control system (DCS) which involves computerized process display and control throughout most of the mill. Such systems significantly improve process control and operator awareness of what is happening in the process.

Recommendation 8

The Panel recommends that the pulp mill process technology proposed by Celgar be approved, since it accords with the best available control technology for minimizing adverse environmental effects for the type of pulp to be produced, and it exceeds the most stringent standards described by the federal and provincial governments during the Panel's public hearings.

Recommendation 9

The Panel recommends that the environmental standards for the mill be based on the performance achievable under best available control technology as proposed by Celgar.

5.1.3 Effectiveness in Reducing Organochlorines

There is considerable pressure from the public and government for the pulp industry to reduce organochlorine discharges (Figure 13). This concern was expressed many times during the hearings and dioxins were singled out as specific organochlorines giving rise to fears for human and other animal health. At the time of the hearings the proposed provincial regulatory goal was 1.5 kg/ADt, to be achieved by 1994. This number refers to adsorbable organohalogens (AOX) which in pulp mill discharges is predominantly adsorbable organochlorine. Recent provincial regulations require that AOX discharges for all pulp mills meet a standard of 2.5kg/ADt by 1994. The Province of British Columbia has also stated that their objective is to adopt a regulatory standard of 1.5kg/ADt, subject to studies to be completed in two years.[9]

Organochlorines are produced mainly from the use of chlorine in the pulp bleaching process with a much smaller quantity arising from the use of chlorine dioxide. Celgar

1. Celgar Pulp Co., Additional Information, August, 1990, p. 23; "emissions" in this statement includes both air emissions and liquid effluents.
2. Ministry of Environment, Document No. 55, Technical Hearings, p.29.
3. Ibid., p.5. (Note: proposed regulations have, as of December 1990, been adopted limiting AOX discharge in effluent to 2.5 kg/ADt as per the "Pulp Mill and Pulp and Paper Mill Liquid Effluent Control Regulation" pursuant to the Waste Management Act, Province of British Columbia and a target of 1.5 kg/Adt has been endorsed.)
4. Mr. C. Johnson, Ministry of Environment, Technical Hearings Transcripts, Vol. 4, p.1041.
5. Department of the Environment and Department of Fisheries and Oceans, Technical Hearings Document No. 53, p.24.
6. Mr. H. Hargback, AF-Industrins Processkonsult AB, Technical Hearings Document No. 85, p.2.
7. Mr. B. Prough, Celgar Pulp Company, Technical Hearings Transcripts, Vol.8, p.2008.
8. Mr. W. Mackay, H.A. Simons Ltd., Technical Hearings Transcripts, Vol. 4, p. 848-849, 853.
9. Ministry of Environment, Press Release re "Pulp Mill and Pulp and Paper Mill Liquid Effluent Control Regulation", Dec. 14,1990.

stated that their goal is the eventual elimination of the use of (elemental) chlorine[10].

Considerable recent research, largely carried out in Scandinavia, has shown how chlorine usage can be very significantly reduced. After reviewing each major component of the proposed mill, the Panel determined that the process proposed by Celgar utilizes all of the major technology currently available and proven for reduction in chlorine usage. This includes:

Extended Delignification - The proposed MCC system allows increased removal of lignin in cooking while maintaining required pulp quality. This results in reduced bleaching requirement and thus less chlorine usage.

Oxygen Delignification - This stage removes more lignin before bleaching.

High Efficiency Brown Stock Washing - Reduced bleach requirement is achieved by efficiently washing out dissolved solids from the unbleached pulp. The mill design assumes 5 kg Chemical Oxygen Demand (COD)/tonne which is very good. A predicted level of 2 kg COD/tonne stated in the hearings[11] would be excellent.

Good Mixing of Chlorine/Chlorine Dioxide with Pulp - The mixers designated for the new process are state of the art and will reduce organochlorine formation by minimizing concentration of the bleaching chemicals.

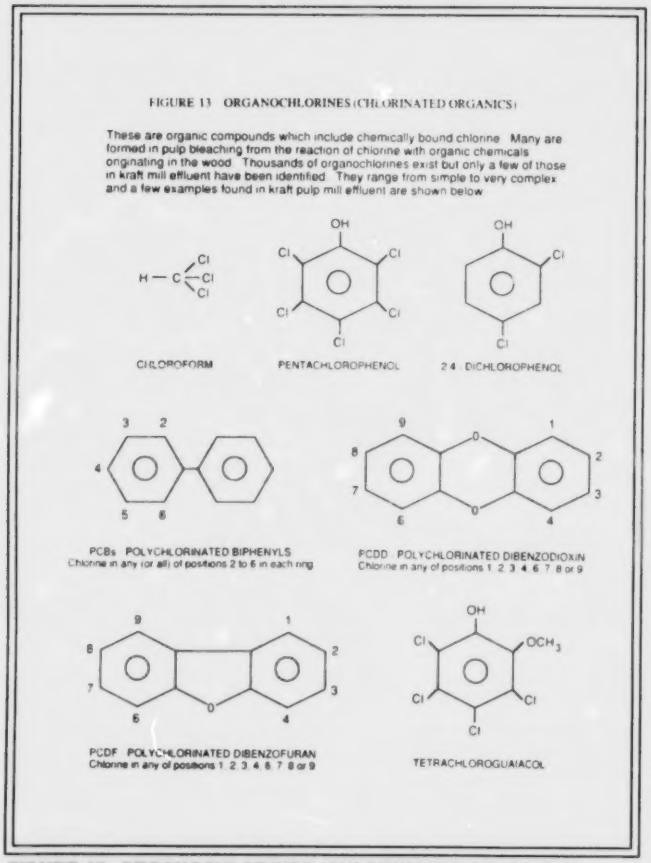


FIGURE 13 ORGANOCHLORINES (CHLORINATED ORGANICS)
These are organic compounds which include chemically bound chlorine. Many are formed in pulp bleaching from the reaction of chlorine with organic chemicals originating in the wood. Thousands of organochlorines exist but only a few of those in kraft mill effluent have been identified. They range from simple to very complex and a few examples found in kraft pulp mill effluent are shown below
CHLOROFORM
PENTACHLOROPHENOL
2 4 DICHLOROPHENOL
PCBs POLYCHLORINATED BIPHENYLS
Chlorine in any (or all) of positions 2 to 6 in each ring
PCDD POLYCHLORINATED DIBENZODIOXIN
Chlorine in any of positions 1 2 3 4 6 7 8 or 9
PCDF POLYCHLORINATED DIBENZOFURAN
Chlorine in any of positions 1 2 3 4 6 7 8 or 9
TETRACHLOROGUAIACOL

FIGURE 13. ORGANOCHLORINES (CHLORINATED ORGANICS).

Increasing the Bleaching Power of the Non-chlorine Stages - The most recent advances applicable to the Celgar operation would be the use of oxygen and peroxide in the extraction stage. Both of these form part of the Celgar proposal.

Substitution of Chlorine with Chlorine Dioxide - Celgar proposed to substitute 70% of the chlorine with chlorine dioxide with an ultimate goal of substituting 100%.

Celgar must also maintain its vigilance in avoiding contamination by or use of dioxin and furan precursors, such as pentachlorophenol wood preservative treated chips, in the process.

The percentage of chlorine present in chlorine dioxide can be a factor in organochlorine formation. The generator was stated to be designed for 98% pure chlorine dioxide, which is satisfactory.

The levels of adsorbable organohalogens (AOX), are predicted to be 2.0 kg/ADt in the untreated effluent.[12] They estimated a 14% reduction during neutralization and a 40% reduction during secondary treatment. After treatment, AOX levels are estimated to be 1.03 kg/ADt.[13] Further discussion of AOX and dioxin and furan levels is provided in Chapter 6.

Various participants noted that, while there exist other mills which operate without chlorine, the production of high brightness and high strength market kraft pulp currently requires the use of some chlorine. The federal Department of the Environment representative, for example, stated:

> With respect to bleaching, we acknowledge that there are no kraft mills in operation that produce fully bleached softwood kraft market pulp without the use of chlorine. We also acknowledge that Celgar cannot totally eliminate chlorine while maintaining their product quality at this time.[14]

The Ministry of Environment also stated:

> The company's desire to produce pulp that meets current market requirements at present time drives them towards the use of some chlorine. Celgar has committed to use at least 70 per cent chlorine dioxide substitution for chlorine gas, and to use hydrogen peroxide in the extraction stages. They have committed to installation of a chlorine dioxide generator size so that should the technology change and/or market demand change, up to 100 per cent chlorine dioxide substitution could be used.

The company has also indicated to the Ministry of Environment that the bleaching process will be designed to be as flexible as possible, so that should consumer requirement change to either a lower brightness of pulp, or change in technology, this new technology, could be installed.[15]

The predicted levels of organochlorine discharges were

10. Mr. W. Mackay, Technical Hearings Transcripts, Vol.4, p.850; Mr. L. Parnell, Technical Hearings Transcripts, Vol.9, p.2041.
11. Mr. J. Prough, Technical Hearings transcripts, Vol.8, p.2008.
12. Celgar Pulp Company, Additional Information, August 1990, p.19.
13. Celgar Pulp Company, Stage II Report, Vol. I "Overview and Environmental Summary," July 1990, p. 49.
14. Mr. D. McIlroy, Department of the Environment, Technical Hearings Transcripts, Vol. 4, p.986.
15. Ministry of Environment, Document No. 55, p. 8, 25; Mr. C. Johnson, Technical Hearings transcripts, Vol. 4, p. 1030.

considered by the Ministry of Environment to be a long-term annual average. The monthly average could range as high as 1.5 kg/ADt.[16] Other experts, notably Dr. Sprague, found Celgar's predictions of performance to be conservative and stated that the AOX estimates are probably a little higher than will actually be found when the mill is in normal operation.[17]

The technical presentations showed that the proposed pulping, bleaching and treatment technology will result in substantial reductions in discharge of chlorinated organic compounds over existing levels. Although the Panel heard slightly different estimates of the potential loadings, all of these predictions were within the proposed provincial regulatory goal of 1.5 kg/ADt levels for AOX discharges from pulp mills.

5.2 Process Operation

5.2.1 Construction and Start-up Phase

The construction and start-up phases will involve constructing and testing new components of the mill, replacing existing equipment and bringing the new operations into production. The current mill will be operating during the three year construction period, with continued variance from provincial pollution control objectives. During the initial operational phase it is not expected that a new mill would meet the predicted levels of pollutant discharges.

Considerable testing and fine-tuning of plant equipment would be required to meet operational design specifications. Kamyr's representative stated that they had at least six major start-ups last year and that while more problems have been encountered during this phase, normal operational procedures are capable of handling such problems.[18] Nevertheless, it is not expected that effluent and emission concentrations will meet operational standards immediately on start-up. The Ministry of Environment anticipates construction and start-up phases lasting for three years of construction and one year of initial operation:

> It is expected that the existing mill would operate in approximately its current configuration for the next 3 years while the new mill components are constructed alongside the old mill. For this period of time the effluent quality limits would recognize that none of the new technology would be functioning. Once the new mill is completed (with the exception of the chlorine dioxide generator) a second set of effluent quality limits would become effective. It is expected that these limits would approximate the values used in the proposed Provincial Regulations discussed above, with the exception that the AOX requirement may not be met. The need for more relaxed limits, compared to what has been identified in the Stage 2 report, is related to the fact that this mill will be starting up many technologies all at once and there are likely to be technical difficulties in the startup phase. It is envisioned that the startup effluent quality limits would remain in effect for a maximum period of one year.[19]

Other participants emphasized the need for careful discharge monitoring and control, and monitoring of effects in the receiving environment during this critical construction and start-up phase. Significant adverse environmental effects could potentially occur if this phase of the changeover is not carefully controlled. Scheduling of construction could also assist in minimizing effects during this period. For example, the Washington Department of Ecology urged action to reduce effluent contaminants as soon as possible. They suggested construction of the treatment system as an early component in the construction of the modernization project.[20]

The question of minimizing AOX during the construction period, from the point of view of effluent concentration and worker exposure was raised during the hearings.[21] In addition to environmental aspects, market pressure relative to AOX is also a factor since some sections of the market are demanding reduced AOX in the pulp. Peroxide use prior to the start-up of the new system is one possible action plus diligent operation of cooking, washing and bleaching. Fluctuating furan levels in the pulp have been discovered by Celgar and their research in this area could lead to reduced AOX in the effluent and the product.

Recommendation 10

The Panel recommends that the effluent treatment system be constructed, if possible, during the initial phases of the three year construction program, thereby the effluent streams in the existing mill would receive secondary treatment, in accordance with a schedule to be approved by the British Columbia Ministry of Environment.

Recommendation 11

The Panel recommends that, in order to minimize the formation of chlorinated organics, especially dioxins and furans, during the construction period of the expanded mill, Celgar be required:

(a) to investigate and test the use of peroxide with either single or multi-point addition;

(b) to assess cooking and bleaching conditions; and

(c) to continue its research into fluctuating furan levels in the pulp, and if possible, to use the results to reduce the levels.

5.2.2 Operating Capacity and Upsets

The proposed mill is projected to produce 1200 ADt/day. This is an average production rate and variability can be

16. Mr. C. Johnson, ibid., p.1033.
17. J.B. Sprague Associates Ltd., Document No. 58, p. 5.
18. Mr. B. Prough, Technical Hearings Transcripts, Vol. 8, p. 1996.
19. Ministry of Environment, Document No. 55, p. 25.
20. Department of Ecology, State of Washington, Technical Hearings Document No.62.
21. Mr. L. Parnell, Technical Hearings Transcripts, Vol. 9, p. 2044, et. seq.

expected in day to day operation. Various participants expressed concern about the actual production output of the mill since historical production had at certain times exceeded design capacity, principally that of the recovery boiler (too small to properly process all of the black liquor generated by the mill).

Operating upsets are also known to occur in pulp mills such that design standards for effluent and emissions would be occasionally exceeded. Celgar staff recognized that the processes are subject to variable product outputs which can affect effluent quality. Members of the Pulp, Paper and Woodworkers Union also noted that operating upsets can occur in the digester and effluent treatment systems and that increased use of chlorine often results from operating upsets in digesters.[22]

It is normal for various stages of the process to occasionally operate at lower or greater tonnage rates than the overall mill designed rate. This is due to problems causing process slowdown and the subsequent need to catch up to replenish storage levels. Operation of the recovery boiler at increased rates where emission quality is impaired will be prevented by the restraint of emission standards and emission monitoring. This restraint is effective relative to all process stages.

Several participants suggested that a reduction in the overall mill design rate would be desirable to reduce total pollutants. The mandate of the panel was to assess the project under review, namely a 1200 ADt per day pulp mill. The non-viability of modernization without expansion was outlined by Celgar.[23] The Panel's approach was to determine if the impacts of the project under review would be acceptable. The proposed mill production rate will govern sizing of BACT process equipment, and Celgar's stated performance of this equipment should form a basis for the environmental standards to be applied. Fluctuations in tonnage rates or other process conditions within the overall mill process could be acceptable if environmental performance to the full BACT capability is not sacrificed. However, the project's acceptability to the Panel was also based on quantity of pollutants released, availability of wood supply, and transportation issues related to an anticipated overall mill tonnage rate of 1200 ADt per day. If BACT is found to be capable of achieving pollutant levels better than imposed government standards, then the company should operate to those better levels rather than using them as a means of increasing average tonnage rate above 1200 ADt per day.

5.2.3 Research Program into Chlorine Elimination

Celgar indicated that their research program is in a very preliminary form and is coordinated with that of their other mill operations in North America.[24] The company stated that their goal is a chlorine-free mill. Further indications of the program underway to attain this goal are needed. However, it should be noted that major research is also being carried out by the fibre line manufacturer which includes 100% ClO_2 bleaching and use of ozone.[25]

Recommendation 12

The Panel recommends that Celgar be required to demonstrate that it is sponsoring or carrying out research to reduce elemental chlorine usage. The research should include investigation of potential ozone usage. An annual report on the research program should be submitted to the British Columbia Ministry of Environment.

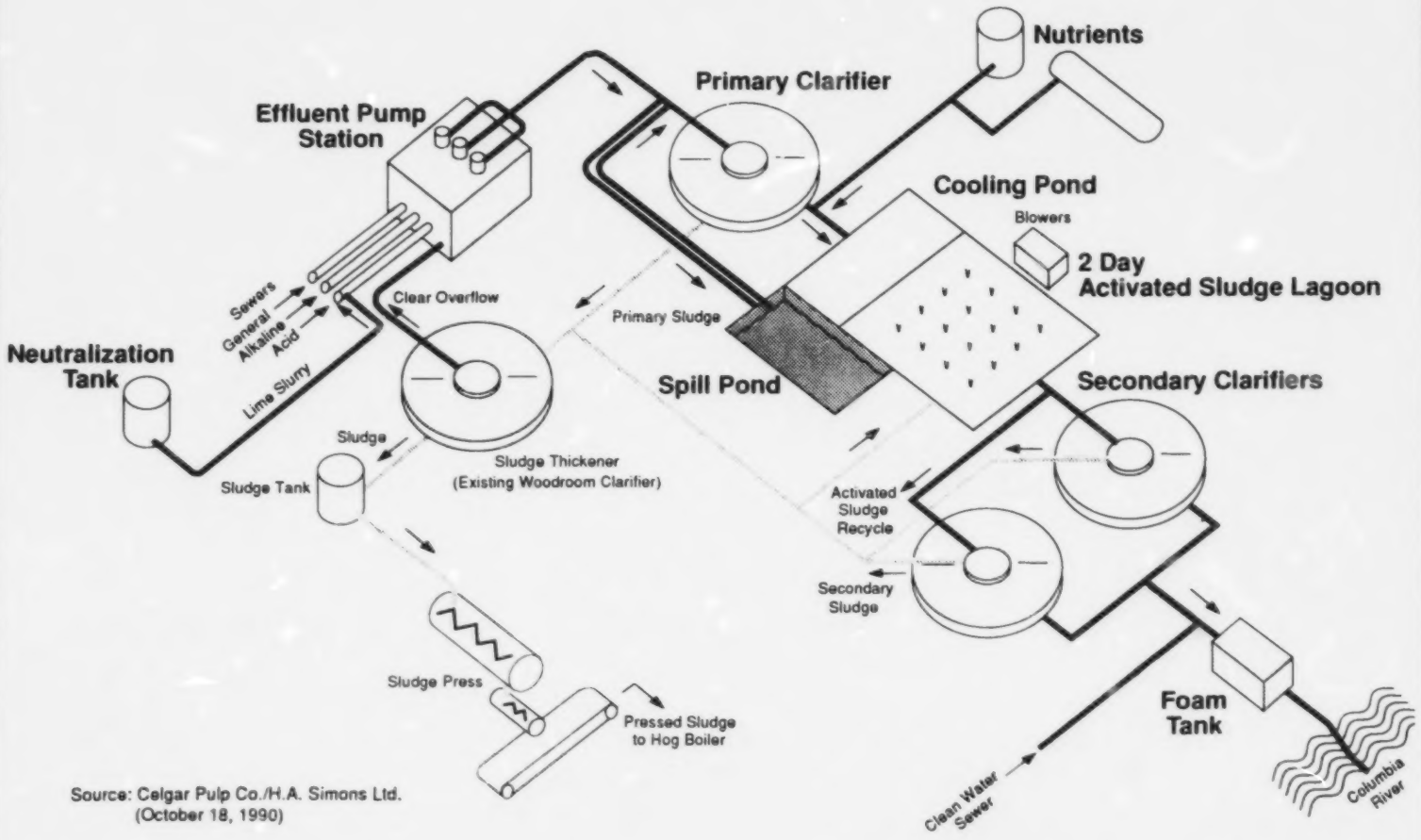
The Panel concludes that the proposed pulp mill meets the definition of "best available control technology" for the type of product produced and is capable of performing to design specifications and impact assessment predictions. The lack of experience in combining the proposed technology all in one mill requires a need for monitoring and adjustment of the equipment especially during the critical transition and start-up phase. Many of the predictions of effluent quality are best estimates of treatment efficiencies which have yet to be demonstrated as consistently achievable over the long term for similar state-of-the-art bleached kraft mills. Similarly, predictions of air emissions have an element of imprecision due to a lack of data on the actual performance of the proposed design. However, the design which has been proposed, with further consideration of environmental concerns in final design, and due diligence in operations and monitoring, provides an acceptable basis for ensuring that any environmental risks will be minimized.

5.3 Liquid Effluent Control and Treatment

5.3.1 Proposed Treatment System

Celgar proposes an effluent treatment system based on a 48-hr retention activated sludge treatment process. The treatment facility would be located 2 km from the mill at a site near the Keenleyside Dam. Figure 14 shows the major components of the treatment system. The three main sewers from the mill will feed a primary clarifier where suspended solids are removed. The effluent is then fed to a cooling and equalization pond before entering the activated sludge aeration pond where bacterial action reduces the contaminants. The treated effluent then flows to two parallel secondary clarifiers for removal of biosolids, of which some are returned to the treatment pond and some are sent to the hog boiler. This clarified effluent then flows back to the mill for discharge from the foam tank and diffuser. A spill pond is capable of holding a volume equivalent to 24 hours of pulp production of 1200 ADt per day.

22. Mr. B. Reiter, Pulp, Paper and Woodworkers Union, Technical Hearings Transcripts, Vol. 4, p. 911.
23. Mr. L. Parnell, Celgar Pulp Company, Community Hearings Transcripts, Vol. 1, p. 17.
24. Mr. L. Parnell, Celgar Pulp Company, Technical Hearings Transcripts, Vol. 8, p. 1999.
25. Mr. B. Prough, Celgar Pulp Company, Technical Hearings Transcripts, Vol.8, p.2001, 2008.



Source: Celgar Pulp Co./H.A. Simons Ltd. (October 18, 1990)

FIGURE 14. CELGAR PULP MILL EFFLUENT TREATMENT SYSTEM.

The Ministry of Environment, the Department of the Environment and the Department of Fisheries and Oceans briefs indicated that the proposed treatment system, when designed and operated diligently, would meet the proposed effluent regulations (Table 9).

During the Technical Hearings, additional treatment facilities were discussed. Representatives from the Pulp, Paper and Woodworkers of Canada (PPWC) union referred to other mills which have used settling aids in the secondary clarifier and the potential advantages of tertiary treatment. Celgar's consultants indicated that they had not evaluated tertiary treatment clarifiers but that secondary treatment was sufficient to provide non-acutely toxic effluent.

The Technical Hearings brought to light some doubt over the effects of nutrient discharge levels on attached algal growth in the river and the importance of nutrient control. Excess nutrients could be removed by tertiary treatment.[26] An increase in chlorate concentration in the effluent, resulting from increased use of chlorine dioxide, might also lead to environmental problems. Discussions indicated that a short anaerobic stage in the effluent treatment system could eliminate this problem if it occurs.[27]

Table 9
Celgar Pulp Mill Effluent Characteristics Compared to Proposed Standards

Parameter	Unit of Measure	Proposed B C (a)	Proposed Federal	Existing Mill	Modernized Mill
BOD_5	kg/ADt	5.0 (b)	5.0 (b)	36.5	2.0
	kg/d			19,870	2,400
TSS	kg/ADt	7.5 (b)	7.5 (b)	11.0	2.13
	kg/d			5,978	2,560
pH	—	6.5-8.0	—	6.5	6.5-8
AOX	kg/ADt	1.5 (c)	—	5.1	1.03 (b)
	kg/d	—	—	2,755	1,240
Toxicity ($96\ hr\ LC_{50}$)	%	> 100	> 100	12	> 100
2378 TCDD	—	—	non-detect	—	non-detect
2378 TCDF	—	—	non-detect	—	non-detect
Temperature	°C	35 (max)	—	27.4	35 max
Dissolved O_2	mg/L	> 2.0	—	3.3	> 2.0
Flow	m^3/ADt	—	—	180	67-78
	m^3/d	—	—	98,000	80,400-93,600
Colour	kg/ADt	—	—	424	73
	kg/d	—	—	231,280	86,700
TEQ TCDD	mg/d	—	—	< 4.4	< 0.055
	mg/year	—	—	< 1,452	< 18.5

Notes: (a) as of July 3, 1990.
(b) annual average.
(c) monthly average at end of 1994 (as proposed at the time of the hearings and later reduced to 2.5 kg/ADt).
(d) refers to the weight of platinum in chlor-platinate ion that is required to produce an aqueous solution the colour of the effluent.

Source: Celgar Pulp Co., Stage II Report; Technical Hearing Document No. 57; Mr. J. Payne, Celgar Pulp Co., Technical Hearing transcripts, p. 1122 - 23.

Recommendation 13

The Panel recommends that the effluent treatment system be designed to accommodate the future addition of tertiary treatment, as well as a short anaerobic stage of treatment, if monitoring indicates that these are required to achieve predicted discharge qualities (see Recommendations 27 and 30).

5.3.2 Capacity of Treatment Stages

The effluent treatment system is proposed to have a cooling and equalization pond and two treatment ponds. There are some indications that the cooling and equalization pond may be too small.[28] Proper neutralization requires adequate sized storage tanks to accommodate large changes in pH in the effluent. Doubts were also expressed about the capacity of the

26. Dr. O. Turk, NovaTech Consultants Ltd., Technical Hearings Transcripts, Vol.9, p.2047.
27. Mr. H. Hargback, AF-Industrins Processkonsult AB, Technical Hearings Transcripts, Vol.9, p.2053.
28. Mr. H. Hargback, op. cit. p.2043; Technical Hearings Document No. 85.2.

acid system during the start-up period and suggested another source of acid during this period.

The aeration pond has a design capacity of 48 hours. This is considered sufficient to provide for effective treatment of the effluent.

Recommendation 14

The Panel recommends that, in the final detailed design of the effluent treatment system, the size of the cooling and equalization pond be checked to determine if any expansion is required.

5.3.3 System Performance

On the basis of the data presented, the proposed treatment system would be effective at producing effluent quality well within the regulatory objectives set by government. Table 9 shows the predicted effluent characteristics compared to the existing mill and government standards.

Some data suggested that activated sludge systems are preferable to aerated lagoon systems in the removal of AOX.[29] Experts also indicated that activated sludge systems have greater operational variability and require more in-plant control and monitoring, particularly in regard to biochemical oxygen demand (BOD) and suspended solids removal.[30] Other information was presented indicating that activated sludge systems do not have high variability if properly designed and operated.[31] Extended aeration treatment systems, similar to the proposed system, are apparently more stable than high rate systems and no difference has been found in the performance of air and oxygen activated sludge systems.[32]

Another issue focussing on effluent treatment performance was the inability of Celgar to confirm that the effluent will not be acutely toxic prior to dilution with cooling water, although observations of similar systems suggest that it will not be acutely toxic. The Department of the Environment and the Department of Fisheries and Oceans believed that the proposed activated sludge treatment system should be able to produce a non-acutely toxic effluent without dilution if that system is designed and operated properly. The PPWC union, in particular, expressed concerns about the lack of guarantees on non-acute toxicity prior to dilution and the need for effective monitoring.

While the experience shows that the proposed technology has a proven record of meeting specifications, there nevertheless remain uncertainties about effluent quality. These clearly impose limits on the ability to provide assurances of non-acute toxicity and therefore some dependence is placed on dilution of the effluent prior to its discharge to the Columbia River. The issues of treatment system performance indicate the importance of continual monitoring and control of process streams.

5.3.4 Effluent Monitoring

Monitoring of the process streams and discharge effluent is a major issue affecting the environmental performance of the proposed mill. Celgar proposes to establish a series of monitoring stations using both continuous analyzers and grab samples. Continuous monitoring data would be entered into a computerized system capable of alarm warning, analyzing trends, adjusting process conditions, producing reports and archiving data. Celgar proposes to monitor the effluent streams and emissions at various stages of processing, including the inlet and outlet of every unit within the treatment system.

The company acknowledged the problems of effluent quality in the existing mill. They stated that the monitoring of final effluent discharge for the proposed mill will meet and in some cases exceed government requirements.[33] Celgar also committed to publishing an annual report on the results of the monitoring.[34]

Many of the technical participants emphasized the importance of monitoring effluent quality because of uncertainties about the perceived performance of individual mill equipment and the overall process design. The Ministry of Environment noted the need to carefully monitor pH and nutrients for efficient effluent treatment and the Ministry of Environment, the Department of the Environment and the Department of Fisheries and Oceans indicated that the 96 hour LC_{50} acute toxicity test[35] would be a cornerstone to regulatory controls.

Doubts were also expressed about commitments to effluent monitoring given the historical record of non-compliance of the existing mill. Representation from the Kootenay Coalition for an EARP referred to a series of violations of the current waste management variance permit between 1988 and 1990 and a lack of confidence in discharge monitoring and enforcement performance.[36]

Details of the specific in-plant and discharge monitoring procedures were not provided. The company and government agencies indicated that monitoring requirements would be determined during the permitting stage. It was recognized by some participants that 96 hour acute toxicity tests may need to be supplemented by a wider range of acute and chronic toxicity tests of the process streams and discharge effluent. Consultants to the Panel recommended the use of rapid assessment tests which monitor biological effects on full or partial life cycle stages of test organisms. The Panel was also provided with examples of protocol biological monitoring tests to be incorporated into the proposed federal effluent regulations for pulp and paper mills.

29. Dr. K. Hall, Technical Hearings Transcripts, Vol. 8, p.1843; Department of the Environment and the Department of Fisheries and Oceans, op. cit., p.25.
30. Mr. M. Gordon, McLeay and Associates, Technical Hearings Transcripts, Vol. 8, p.1854.
31. Mr. L. Galloway, H.A. Simons, Letter to Celgar Pulp Company Re: Response to Questions and Issues Raised During the Technical Hearings, Nov. 9, 1990, pp. 6-10.
32. Dr. O. Turk, op. cit., p. 1935; Dr. O. Turk, NovaTec Consultants Ltd., Letter to H.A. Simons Ltd. Re: Response to McLelay Report Comments About Effluent Variability, Nov.9, 1990.
33. Mr. B. Briscoe, Celgar Pulp Company, Technical Hearings Transcripts, Vol. 4, p.876.
34. Celgar Pulp Co., Additional Information, August, 1990, p.80.
35. A test of the survival of organisms in an effluent concentration resulting in 50% mortality of test animals after 96 hours.
36. Mr. F. and Ms. L. Ruljancich, Technical Hearings Transcripts, Vol. 3, pp. 748-796.

Recommendation 15

The Panel recommends that Celgar be required to establish a routine effluent monitoring program, which incorporates appropriate chemical and a carefully selected array of biological tests by qualified environmental technicians at all stages of effluent treatment; and that the results of those tests be cued to specific process management responses to control the quality of any discharges.

Recommendation 16

The Panel recommends that manual backup monitoring be established to support and supplement automated effluent and emission monitoring and alarms.

5.4 Air Emission Control and Treatment

5.4.1 Emission Rates

The data presented by Celgar and others indicate major reductions in most air contaminants from current levels (Table 10). The high solids firing technology and low odour recovery boiler operations which have been proposed significantly reduce emissions of total reduced sulphur (TRS), but result in higher total sulphur dioxide (SO_2) emissions from the expanded mill. The latter is reduced on a per tonne basis. Table 10 compares the current and predicted emission discharges. Both the federal and provincial governments accepted that the proposed technology would meet regulatory objectives and accord with BACT.

The major sources of emissions are the stacks at the lime kiln, the power boilers, the recovery boiler, the dissolving tanks associated with the recovery boiler, the bleach plant exhaust and the chlorine dioxide plant exhaust. The major contaminants that pose a concern are the increased levels of SO_2 from the reduction through burning of TRS, in combination with the relatively unchanged levels of NO_x from various combustion sources. According to the technical presentations, other levels of air contaminants are expected to be controlled within manageable levels provided the plant operates to design specifications.

Ongoing monitoring, review of operations and appropriate adjustment or addition of emission control equipment were suggested by government agencies as the most desirable approach to minimizing hazardous emissions.

5.4.2 Incineration of Total Reduced Sulphur

One of the trade-offs associated with the proposed technology to reduce TRS by 97% is a projected increase of 34% in total SO_2 released, with mill expansion. However, high solids firing reduces SO_2 on a per tonne basis. The incineration of TRS in the recovery furnace will directly contribute to these higher levels. Use of a scrubber to remove SO_2 gases from the recovery boiler stack was not considered by the Ministry of Environment to be a suitable solution. The lime kiln also plays a counter role in reducing SO_2 levels since incineration of non-condensable gases (NCG) in the kiln results in removal of sulphur by reaction with the lime. However, the lime kiln will not operate at certain times due to maintenance and therefore, will not offer a continuous abatement function.

Some uncertainties exist about the projected sulphur dioxide emissions from the recovery boiler, power boiler and kiln. Celgar's consultants described the lack of reliable technical data on actual values achieved or in terms of variability from high solids firing.[37] It was also noted that predicted TRS emission rates may be too optimistic and therefore SO_2 levels may be less than predicted. When TRS is burned in a wood-fired power boiler, sulphur dioxide may be almost totally eliminated by absorption on carbon or reaction with the alkaline ash which is produced in the boiler.[38]

High volume low concentration (HVLC) non-condensable gases containing TRS will be burned in the No. 2 power boiler as will low volume high concentration (LVHC) gases when the lime kiln is down. It will be possible at the Celgar mill to compare the results of burning LVHC gases in the lime kiln and the power boiler and to determine if power boiler incineration of TRS offers a means of reducing SO_2 emissions.

In any event, the capability of burning the LVHC gases in both the No. 2 power boiler and the kiln should be maintained since it offers incineration of these gases when one of the two pieces of equipment is not operating.

Recommendation 17

The Panel recommends that Celgar be required to evaluate the incineration of total reduced sulphur in the power boiler as a means of reducing SO_2 emissions.

5.4.3 Incineration of Sludge

Various submissions referred to uncertainties in the potential emission of adsorbable organohalogen compounds from the proposed burning of sludge from the effluent treatment plant in the power boiler. Both the federal and provincial governments indicated that more testing is required to determine whether incineration of sludge will result in discharges of dioxins and other AOX compounds which exceed acceptable levels. A test burn was proposed. The Ministry of Environment indicated that a separate incinerator may be required if tests show inadequate destruction of AOX compounds.

37. Mr. B. Briscoe, op. cit., p. 2012.

38. Dr. F. Murray, Technical Hearings Transcripts, Vol. 10, p. 2379.

TABLE 10
COMPARISON OF EXISTING AND MODERNIZED MILL ANNUAL EMISSIONS[1] AT CELGAR PULP MILL

Emission	Contaminant Expressed As	Existing Mill Actual t/yr	Existing Mill Actual kg/ADt	Modernized Mill Estimated t/yr	Modernized Mill Estimated kg/ADt	Change t/yr (%)
Particulate Matter (PM)		1,294	6.8	191	0.45	-85
Total Reduced Sulphur (TRS)	H_2S	1,706	8.9	45	0.11	-97
Sulphur Dioxide (SO_2)	SO_2	227	1.2	305	0.73	+34
Nitrogen Oxides (NO_x)	NO_x	1,246	6.5	1,204	2.9	-3
Carbon Monoxide (CO)	CO	18,310	95.9	711	1.69	-96
Volatile Organic Compounds (VOC)	CH_4	254	1.33	260	0.62	+2
Chlorine/Chlorine Dioxide (Cl_2/ClO_2)	Cl_2	57	0.3	4	0.01	-93
Total Combined Mass Emission (t/yr)		22,840	120	2,460	13	-89

[1] Emissions are based on operating 350 days/year for both the existing mill and the modernized mill (at annual average production rate).

Source: Celgar Pulp Co., 1990.

Recommendation 18

The Panel recommends that the federal and provincial governments undertake their planned controlled test burn of an effluent sludge, comparable to the sludge of Celgar's proposal, as soon as practicable.

Recommendation 19

The Panel recommends that Celgar be required to make provision for later adoption of sludge incineration, if test results are found to be satisfactory.

5.4.4 Emissions from Effluent Treatment

The proposed effluent treatment facilities were identified as a potential source of TRS emissions. Celgar proposes to limit these emissions by stripping contaminated condensate prior to effluent treatment.

The Ministry of Environment indicated that these emissions can have a marked influence on nearby ground level air quality.[39] The projected emission rate of TRS is 1.0 gram per second (g/s) compared to 1.7 g/s from the elevated stack sources. The approach to estimating TRS levels and plume behaviour from the effluent ponds was inconsistent between the Ministry and Celgar's consultants.[40] Other presenters also expressed concern about volatilization of TRS from the effluent treatment ponds.[41]

Given the uncertainty of predicted effects, it will be important to monitor the actual emissions and take corrective action where necessary.

5.4.5 Emission Monitoring

Celgar proposes an elaborate air emission monitoring system alongside emission control devices at the recovery boiler, the dissolving tanks, the lime kiln, the power boilers and the bleach plant and chlorine dioxide plant exhausts. The non-condensable gas system will have 25 individual sources for collecting emissions from the plant. The Ministry of Environment presented a preliminary set of stack monitoring requirements which are to be considered as part of the permitting process. They also noted that approval for temporary bypasses of control equipment for maintenance work would only be granted subject to certain conditions which minimize the effects on ambient air quality.

The major issue associated with the design of the proposed monitoring system is the reliability of the alarm and reporting procedures when air emission standards are exceeded. This will be particularly important during the start-up phase when emission variability is most likely.

Recommendation 20

The Panel recommends that Celgar be required to monitor air emissions from the stacks, with alarm and reporting procedures when air emission standards are exceeded.

5.5 SPILL CONTROL

Celgar explained the two types of spill containment and collection systems proposed. One system provides for spills

39. Ministry of Environment, Technical Hearings Document No. 55 (Addendum), p. 23.

40. Ibid., p. 24

41. Mr. C. Him, Pulp, Paper and Woodworkers Union, Local 1, Technical Hearings Document No. 93; Mr. M. Bronough, Technical Hearings Document No. 71.

external to storage and processing tanks and chemical unloading areas. The other system is for spills inside the processing plant such as a tank overflow or valve leakage.

The external spill control design is based on dykes and concrete slabs and trenches around potential spill areas. Spills are contained and directed to the in-plant spill collection system.

The in-plant spill control is designed to recycle process streams, recover the majority of spilled pulp and chemicals and protect the operation of the effluent treatment system. Four trenches in the operating areas will divert spills to a collection sump for return back into the process streams. Two spill ponds are proposed, each capable of storing full effluent flow for 12 hours. Spills are to be reported to the mill manager, government agencies and the public.

Most of the concerns related to spill control were associated with report and response arrangements. State of Washington officials suggested that spill control plans should include notification of U.S. agencies. Public interest groups questioned the voluntary basis for spill reporting. In response, the company noted that detailed spill reporting procedures would be established with the province. The Ministry of Environment indicated that they are considering reporting procedures linking the mill to ministry offices using a computerized data and warning system.

Recommendation 21

The Panel recommends that Celgar be required to prepare a spill control and response plan, in consultation with government agencies, mill workers, and community groups; to provide staff training; and to issue public reports on incidents and responses.

5.6 Environmental Management of Operations

Many individuals spoke to the Panel about the need for a strong commitment from the company and government to protect the environment. The history of environmental problems at the current mill has left a legacy of concern marked by the continual inability of the mill to meet provincial pollution control standards. The following views reflect many of the concerns expressed at the hearings:

> When the Panel is gone, who will remain to monitor the mill. Who will have the authority to tell the mill anything. Who will sacrifice the jobs of 400 people to save the environment and how many toxicity tests can you fail before you have to do something. I've heard through the hearing a request for monitoring. This is the result of lack of trust of Celgar pulp mill. Celgar pulp mill must earn this trust by complying to federal and provincial regulations, and this compliance must be 100%.[42]

In response to these concerns, Celgar emphasized that the technology of the new mill will vastly improve their ability to meet contemporary environmental protection requirements. They described preliminary plans for environmental monitoring and management which will result in discharges which meet or better government regulatory standards.

Proper facilities, trained staff and effective authority are needed to ensure that plant operations fulfill the predictions and expectations of environmental protection. The human element was especially noted:

> I have seen lots of mills which were designed to do a good job, but because of problems in people who had other things on their mind, people who were normally pressured by production demands, they really didn't direct the attention to the environment aspects of the mill that should have been directed there.[43]

The complexities and uncertainties associated with the introduction of new technology requires special training to ensure that plant upsets are minimized and environmental standards are met. Celgar indicated that a training program has been selected which will provide an average 200 hours of training per worker.

Many of the participants in the review process supported the project on the understanding that the proposed equipment will meet design specifications and predictions. They also recommended monitoring programs to provide the feedback mechanism for adjusting operations to meet environmental protection requirements. But environmental management of effluent and air emission monitoring requires appropriate equipment and laboratory facilities, in addition to trained staff.

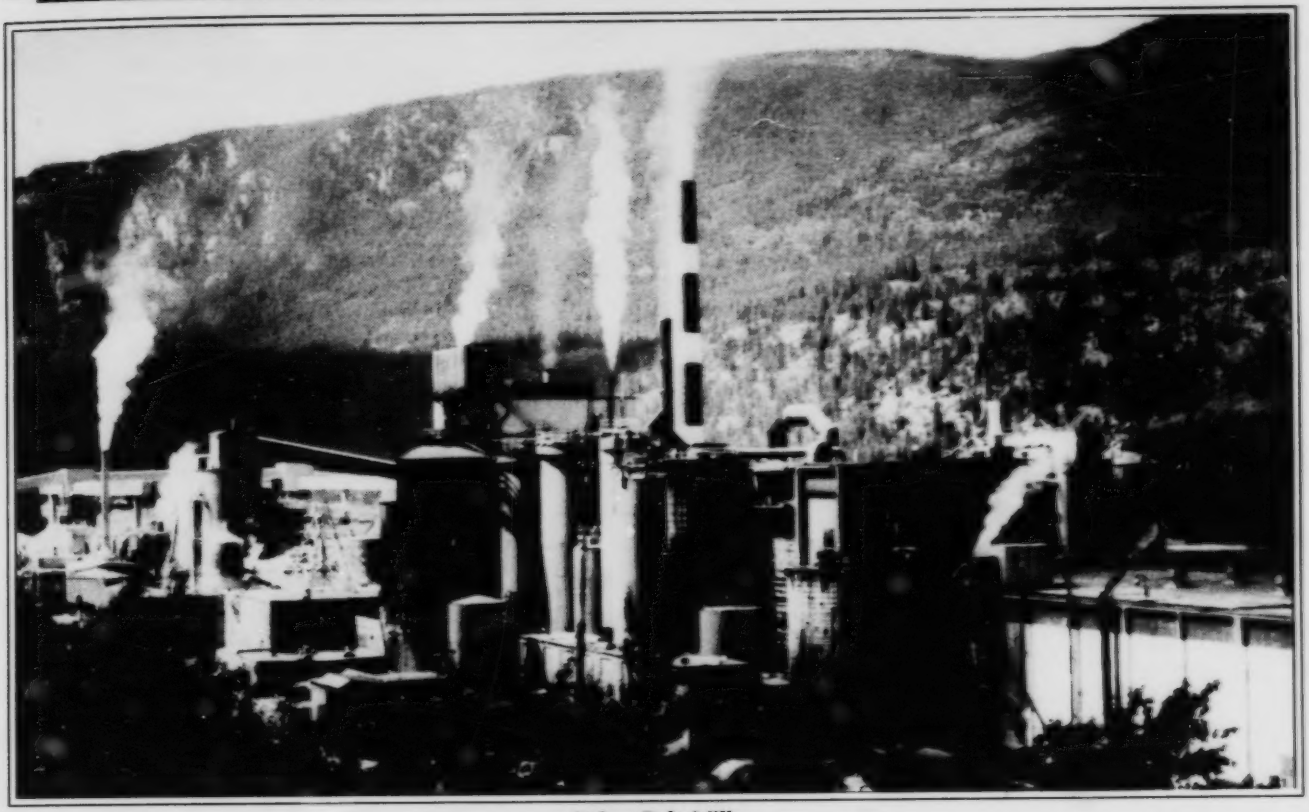
In its Interim Report, the Panel stated that it expects individual and organizational demonstration of Celgar's commitment to monitoring and problem solving. The expectation of environmental protection must permeate policies and practices of the company, its owners, management and all staff, whose activities could affect pollution from the mill. Further, public confidence requires information from Celgar, in terms people can understand, about how the technology and Celgar's operations are protecting their environment.

Recommendation 22

The Panel recommends that Celgar be required to establish a fully equipped environmental laboratory, with the capability to undertake regular monitoring of effluents and emissions, including measurement of toxicity; and that the laboratory be staffed with qualified technicians responsible for the environmental monitoring program.

42. Mr. C. Him, Paper and Woodworkers Union, Local 1, Technical Hearings Transcripts, Vol. 8, p.1817.

43. F. Murray, Technical Hearings Transcripts, Vol. 10, p.2382.



Celgar Pulp Mill.

Recommendation 23

The Panel recommends that Celgar be required to assign a qualified senior level environmental manager at the mill, responsible for ensuring the implementation of Celgar's policies and practices for minimizing adverse environmental consequences of its operations.

Recommendation 24

The Panel recommends that Celgar be required to issue every six months environmental reports designed for the public, documenting the monitoring data, spill occurrence and other aspects of environmental performance at the mill (see also Recommendation 47).

5.7 Energy Production and Consumption

The proposed mill will require approximately 50 megawatts of power. A new turbogenerator has been included in the plant design to produce this power. The heavy black liquor, which contains lignin and spent cooking chemicals from the pulping process, will be burned in the recovery boiler. The heat generated will be used to produce steam which, when passed through the turbogenerator, will supply all of the mill's electrical energy requirements except under maintenance or unusual circumstances. The mill will also be capable of purchasing power during the infrequent periods when the turbogenerator is shut down.

Co-generation of electrical energy alongside pulp production has significant energy conservation benefits for the company and the province. The present mill relies on West Kootenay Power for the majority of its electrical power requirements - approximately 22 megavolt amperes. This will no longer be needed. Hog fuel from the adjacent Westar sawmill will also no longer be required for power generation. The implications of this are discussed in Section 3.6.

The proposed mill is subject to the provisions of the Utilities Commission Act which require that projects obtain approval from the Province prior to construction. Celgar applied for this approval. In reviewing their application, the Ministry of Environment stated that it "is satisfied that any environmental impacts due to cogeneration will be reduced to acceptable levels."[44] No objections or concerns were expressed to the panel regarding the energy co-generation aspects of the project. Indeed, the energy efficiencies gained from the proposed mill are an important benefit from the project.

44. Mr. D. Dryden, Ministry of Environment, correspondence to Energy Project Analysis Branch, Ministry of Energy, Mines and Petroleum Resources, Oct.1, 1990.

Community hearings in Castlegar.

CHAPTER 6: WATER QUALITY AND AQUATIC RESOURCE ISSUES

6.1 EFFLUENT DISPERSION

6.1.1 Flow Regime and Hydraulics

The Columbia River between Hugh Keenleyside dam at Castlegar and Lake Roosevelt reservoir behind Grand Coulee dam in Washington State (Figures 15 and 16) is one of the last free-running sections of the river. The river has a regulated flow controlled by the Keenleyside dam, 3 km upstream of the Celgar pulp mill, and by Kootenay River dams below Nelson. Figure 17 shows the maximum, average and minimum daily discharges of the Columbia River at the Keenleyside dam for the period 1970 - 1989. The low flow period generally occurs in March/April. Peak average river flows normally occur in early August. Minimum daily flow discharges in 1989 were 142 cubic meters per second (m^3/s) at Keenleyside dam, 498 m^3/s at Birchbank and 949 m^3/s at the U.S. border. The increase in flow downstream reflects the input of tributaries, especially Kootenay River and Pend Oreille River (Figure 15). River levels also fluctuate on a daily basis by up to one meter or more as a result of releases at dams.

The inflow of the Kootenay River, 7 km downstream of the mill, influences the hydraulic characteristics of the Columbia River near the pulp mill. Studies undertaken by Celgar showed that the Kootenay River slightly reduces the velocity (3%) and increases the width and depth of the river. These changes in the Columbia River occur quickly in response to the Kootenay River but strong hydraulic damming does not appear to occur.

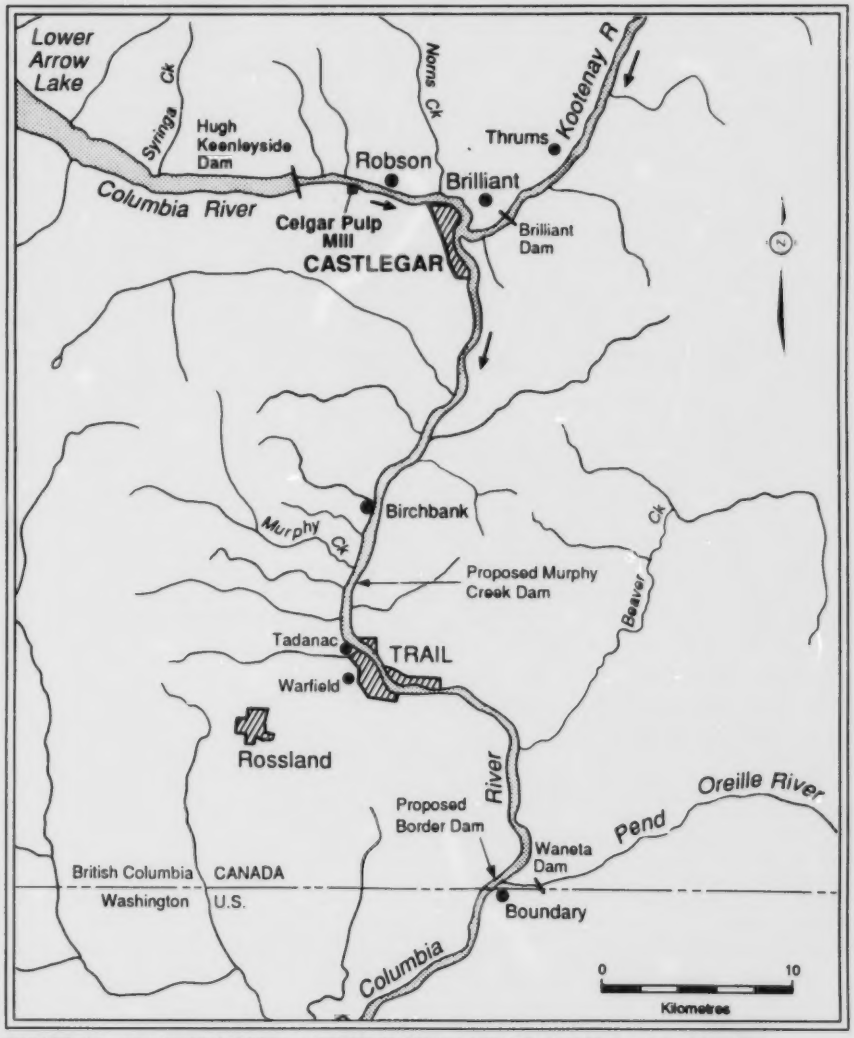


FIGURE 15. COLUMBIA RIVER, LOWER ARROW LAKE TO CANADA - U.S. BORDER.

The river enters Lake Roosevelt (Figure 16) in Washington State, a reservoir about 60 km downstream from the mill. No data were available on flow and sedimentation processes in the lake, although it was stated that it has a high flushing rate (about eight times per year).[1]

6.1.2 Mixing and Dilution

The mixing behaviour and dilution potential of the effluent was modelled using sodium tracer studies and water quality survey data. These studies indicated incomplete mixing 6 km downstream of the mill and full mixing at Birchbank, 29 km downstream. The Stage II Report predicted that the mill effluent will be completely mixed "in the vicinity of" the confluence of the Kootenay River, 12 km downstream. The effluent plume from the existing mill surfaces from 20-210 m downstream of the diffuser, depending mainly on river discharge.

1. Mr. R. Crozier, Ministry of Environment, Technical Hearings Transcripts, Vol. 6, p. 1546.

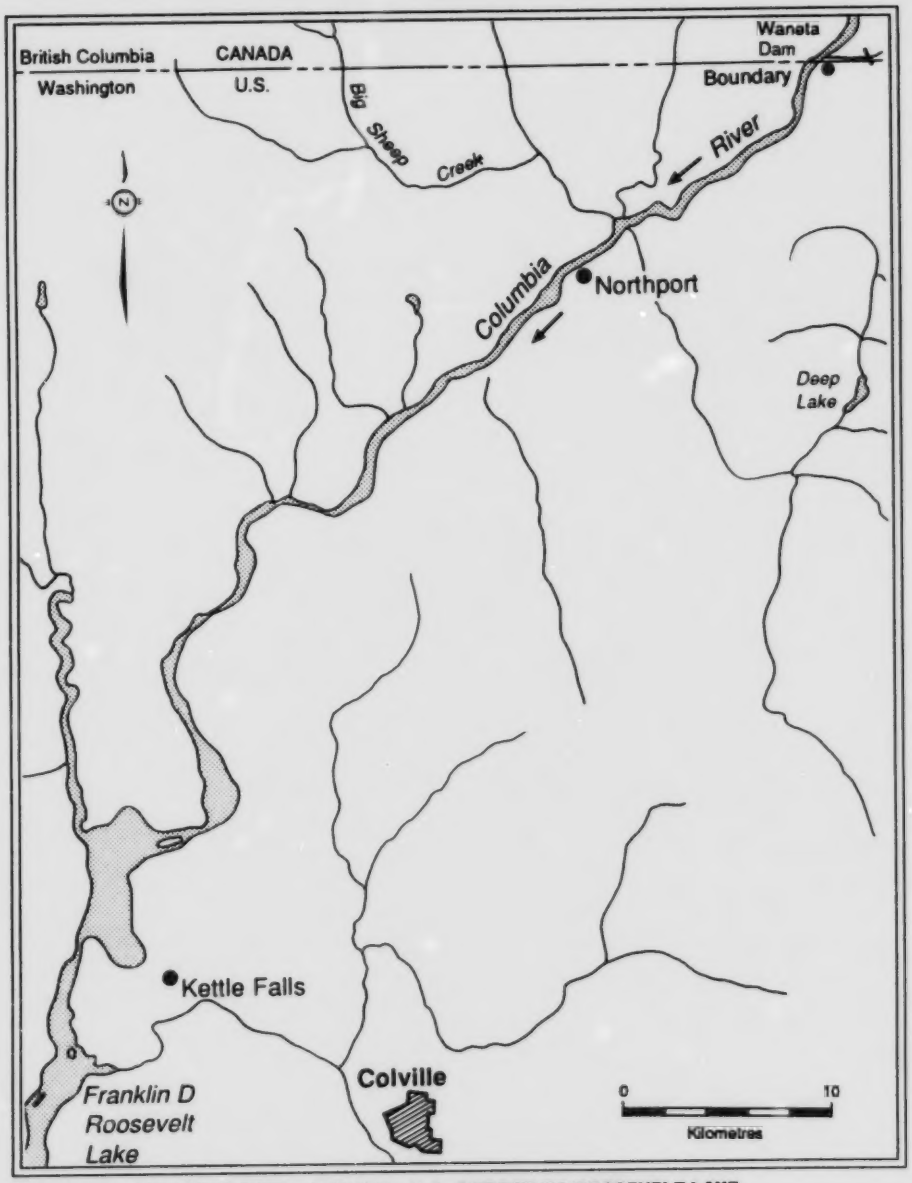


FIGURE 16. COLUMBIA RIVER, CANADA - U.S. BORDER TO ROOSEVELT LAKE.

Computer modelling was also used to estimate the dilution of the effluent immediately downstream of the mill. The effluent concentrations immediately below the outfall will vary with the river's flow regime. Celgar estimated that the concentration can range from 2.1% where the plume surfaces 21 m downstream at low flow of 142 m^3/s in the spring, to 0.75% where the plume surfaces more than 210 m downstream of the diffuser under average winter flow conditions.[2]

Other presentations indicated that uncertainties exist about effluent mixing during certain river flow conditions. Dr. McLeay, for example, stated that a conservative estimate of effluent concentration at the edge of the initial dilution zone (IDZ)[3] is 1.7% and that a concentration of approximately 1% effluent under low flow conditions appears to be representative of expected conditions after complete mixing downstream.[4] Effluent concentrations in the range of 1-2% under low flows present the possibility of sublethal effects.

Celgar predicted that, using average flows as the basis for determining long term exposure levels, the effluent would not have sublethal effects even before complete mixing downstream. However, the flow data indicate that lengthy low flow periods can occur and that plume surfacing and mixing is highly variable. There are enough uncertainties about mixing behaviour and interactions with aquatic organisms to indicate high potential for sublethal effects.

The Panel concludes that incomplete effluent mixing would occur downstream of the mill to the confluence of the Kootenay River, and that this could result in sublethal effects, especially during low flow periods. Monitoring of discharges and receiving conditions is therefore required.

6.1.3 Hydroelectric Developments

The proposed addition of a power plant to the Keenleyside dam is not expected to alter the current range of river flows. B.C. Hydro indicated that the flows are largely controlled by the Columbia River Treaty and they have no plans to change the flow regime. The addition of a power plant to the dam is expected to reduce the present high levels of supersaturated gases which occur near the dam.

B.C. Hydro has also proposed a new dam on the Columbia River near Murphy Creek (Figure 15), but further advancement of the project is unknown. The Department of the Environment and the Department of Fisheries and Oceans indicated that the project would raise the Columbia River about 15 m at the project site and 4 m at the Keenleyside dam under average flow conditions, creating a reservoir in one of

2. EVS Consultants, Clarification of Items Discussed at the Technical Hearings, Nov. 9, 1990.
3. An initial dilution zone is an area where the provincial water quality objectives do not apply and which, by definition, extends 100 m down the river from effluent discharge and across not more than 50% of the river width.
4. Dr. D. McLeay, Technical Hearings Document No. 87.1.

the last free running reaches of the river.[5] No information was provided on the potential effects of dam construction on effluent dispersion and dilution. These could, however, be significant given the importance of river flow and sedimentation to the accumulation of contaminants in the environment. This would need to be considered in future project review processes.

6.2 River Water Quality

6.2.1 Existing Conditions

The Panel heard and received extensive presentations on the state of water quality in the Columbia River between Keenleyside dam and Roosevelt Lake. Many participants emphasized the need to consider the cumulative and synergistic effect of the proposed discharges to the river. The following major water quality issues were identified:

- *dissolved gas supersaturation* occurs below the Keenleyside dam, creating sublethal stresses on fish populations;
- *solids*, consisting of fibre, ash, lime mud, wood debris, algae and fungus, have built up on the river bottom near the Celgar mill into a "fibre mat";
- *heavy metals* (particularly mercury), and slag discharges from Cominco smelter, while reduced from earlier periods, are a source of concern in Canada and the U.S.;
- *chlorinated organic compounds*, notably dioxins and furans, have been measured in certain species of fish at levels exceeding guidelines for human consumption in the mainstem of the Columbia River;
- *colour, odour, foaming and attached algal growth and decomposition* have been occasional sources of public complaint, sometimes in association with fluctuating river flows;
- *river bottom-dwelling (benthic) insect communities* between Celgar mill and the Kootenay River have shifted toward more pollution tolerant species.

The combination of industrial, municipal and public discharges to the river have resulted in a long history of pollution. Downstream loadings also provide an important context for consideration of cumulative effects. One participant described this setting:

> The Columbia River basin includes nine bleached kraft pulp mills, eight non-bleached kraft pulp mills and rayon facilities, former pulp mill sites, and 2,4,5T plants which was contaminated with dioxins, 12 pentachlorophenol-using wood treatment plants, U.S. national Superfund sites and abandoned pentachlorophenol sites, 30 publically-owned treatment works, 37 other types of industrial sites, non-point sources including pesticides and atmospheric deposition from municipal incinerators, and resuspension of contaminated sediments in the water column as the Columbia River is regularly dredged.[6]

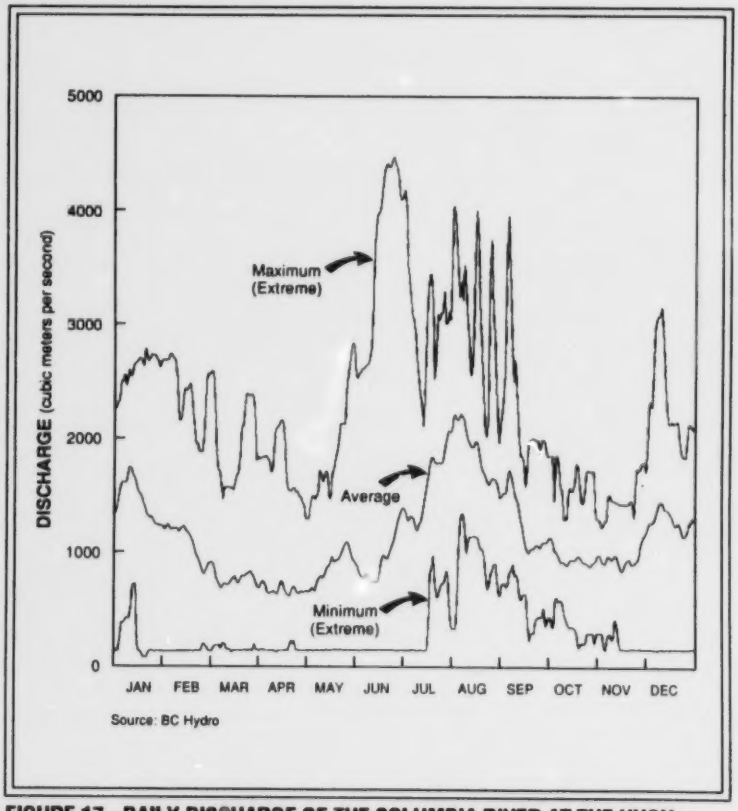


FIGURE 17. DAILY DISCHARGE OF THE COLUMBIA RIVER AT THE HUGH KEENLEYSIDE DAM (1970-1989).

The Panel also heard concerns about water users. The Columbia River provides a source of water supply for the communities of Warfield and Tadanac and a reserve supply for Trail (Figure 15), as well as a supply for unlicenced users. Known groundwater users near the river include the West Brilliant Water Users Community and the City of Castlegar reserve well.

The major industrial users of water are Celgar, Cominco and B.C. Hydro. The river is also used by fish, wildlife and people seeking recreation. Some irrigation use also occurs between Castlegar and the border.

6.2.2 Contaminant Loadings

Changes in pulp mill technology and processes over the thirty year history of the mill have resulted in some reductions in the pollutant loadings compared to the original mill. The current mill nevertheless generates a heavy pollution load on the Columbia River. Table 11 presents the available data on past and projected loadings to the river. The proposed volume of effluent from the new mill is estimated to be 93,600 m^3 per

5. Department of Fisheries and Oceans and the Department of the Environment, Technical Hearings Document No. 53, p. 33.
6. Dr. M. O'Brien, Kootenay Coalition for an EARP, Technical Hearings Transcripts, Vol. 4, p. 1160.

Table 11
Comparison of Mean Daily Effluent Loadings to the Columbia River From Celgar Pulp Mill

Parameter	1975-77[1]	1989	April 1990	Modernized Mill (Long Term Average)
Flow Rate (m^3/d)	119,000	98,000[2]	98,000[2]	93,600 (summer) 80,400 (winter)
Temp. (°c)	32	27.4[3]	34	35
Colour (kg/d)	11,947	231,280[4]	94,472	87,600
BOD_5 (kg/d)	23,205	19,870[3]	12,446	2,400
Suspended Solids (kg/d)	21,420	5,978[3]	4,420	2,560
Nitrogen (kg/d) (Total Kjeldahl)	274	—	195	460
Phosphorus (Total) (kg/d)	119	—	50	102
Resin Acids (kg/d)	357	—	67	1.1
AOX (kg/d)	—	2,755[5]	2,176	1,240

1. From Ministry of Environment (1979).
2. Assumed flow.
3. Based on values measured by the Celgar Pulp Co. and submitted to Ministry of Environment for 1989.
4. Based on colour values measured by the mill from Nov., 1989 to March, 1990.
5. Based on CPPA (1989) and testing conducted by Celgar Pulp Co., Nov., 1988 to Jan., 1989.

day during summer and 80,400 during winter - respectively 5% and 18% less than the present volume flow rate of 98,000 m^3 per day.

Effluent water temperature is not expected to be altered appreciably by the new mill. Few taste and odour effects are predicted with the proposed stripping of foul condensate and biological treatment of effluent, although some fish tainting could occur under low flow and incomplete mixing conditions.[7]

Colour, primarily a shade of brown created by lignins in the discharge, is predicted to decline in receiving waters with the proposed mill. The Ministry of Environment estimated that, in the section between the mill and Kootenay River, water colour would not meet the criteria for drinking water use during low flow conditions for approximately 2 weeks per year.

Biochemical oxygen demand showed a strong trend toward declining levels as a result of closure of the woodroom in 1988 and decreased log storage near the sawmill and pulp mill.

Oxygen concentrations have not occurred at levels which threaten fish species, partly because of the well oxygenated discharges from the Keenleyside dam.[8] Modelling of oxygen under low flow/maximum temperature conditions has confirmed that the criteria for the most sensitive salmonid use periods would be met. There are, however, high levels of dissolved gases which occur as a result of the dam and which impose stress on fish populations.

Suspended solids from the Celgar mill have been a major contributor to water pollution in the river. Discharge of solids is particularly important because it provides a sink and transport mechanism for hydrophobic forms of organic contaminants. The extensive fibre mat and wood debris deposits on the river bottom have probably reduced the productivity of the bottom-dwelling invertebrate community and the availability of fish habitat. These organic deposits originate from the Westar sawmill as well as the Celgar pulp mill. The current loadings of suspended solids have decreased dramatically from historical levels and further reductions are projected. The Ministry of Environment stated that the solids would be primarily "biosolids" composed of microscopic particles of partially decomposed waste and bacteria, and the predicted levels would easily meet provincial criteria for the most sensitive river use.[9]

Nutrient loadings are estimated to increase significantly with the new mill. The potential loadings and effects are summarized in Section 6.5. Provided that adequate neutralization of effluent occurs, no effects on pH values of receiving waters are anticipated.

The pulp mill effluent contaminants which pose the greatest concern are the organic compounds, principally chlorinated organics, resin acids and fatty acids. The levels, fate and environmental effects of chlorinated organic compounds are discussed in Section 6.4 and 6.7. AOX, which represents the major group of chlorinated organic compounds, is estimated to be reduced by 40% from current discharge levels.

Celgar reviewed the available information on resin acid concentrations in pulp mill effluent and the effectiveness of biological treatment. They concluded that projected concentrations will be in the low end of the range of estimates of resin acids from pulp mill effluent, due mainly to the resin acid content of the proposed wood chip species and other data which suggest their treatment would remove 90% of non-chlorinated resin acids. No effects are predicted from fatty acids. The Ministry of Environment commented:

> This information suggests that the combination of predicted worst case effluent concentration and worst case river flow produce river resin acid concentrations that are at the lower limit of known effects on sensitive biota. However, we are

7. Dr. D. McLeay, op. cit.
8. Ministry of Environment, Technical Hearings Document No. 55, p. 55
9. Ministry of Environment, op. cit., p. 52.

reasonably confident that the river is adequately protected with respect to resin acids.[10]

Major improvements in water quality are predicted to occur from the current levels of contaminant loadings to the river. The uncertainties which remain relate primarily to groundwater, chlorinated organic compounds, nutrients and biological impacts.

6.3 Groundwater Quality

6.3.1 Potential Risks

Concerns were expressed about the potential leaching of contaminants from the landfill site, chemical handling facilities, hog fuel and chip area and the biotreatment ponds to groundwater and the Columbia River. Leachates are presently being discharged from chip and hog fuel piles and no data on these discharges appear to be available.[11]

Celgar indicated that the proposed spill control system would prevent release of hazardous materials to the environment. The biotreatment pond would also be clay-lined to minimize leakage. They proposed installing groundwater monitoring wells up-gradient and down-gradient from four sites with potential leachate concerns. Chemical analyses and modelling would be undertaken at each site to determine baseline concentrations and changes in AOX, resin acids and other parameters. These would permit detection of any leachate problem and whether additional leachate control is required.

It was estimated that the seepage loss from the biotreatment ponds would be equivalent to 3,456 m^3/day or 3.5% of summer effluent discharge.[12] Monitoring wells would determine if any AOX in the effluent was entering the groundwater. They later advised government that a seepage collection system would be installed to reduce expected losses to 0.25% of the design flow.[13]

Two specific issues associated with facility design were identified by the provincial Ministry of Environment:

- discharge to the ground of leachate collected from the solid waste disposal site would not be approved by permitting authorities; and
- better lining techniques which will reduce seepage loss, including poly liners, should be evaluated before final design of the biotreatment ponds.[14]

6.3.2 Proposed Studies

The Department of the Environment, the Department of Fisheries and Oceans, and the Ministry of Environment supported the proposed hydrogeological assessment to be undertaken by Celgar. They noted that if unacceptable levels of existing or potential contamination are identified, remedial measures will be required, along with further monitoring. Sampling for chlorinated organics may be required, depending on the results of the assessment. The federal government specified nine conditions of the proposed hydrogeological studies which have been agreed upon with the company.[15]

The Panel concludes that the estimated seepage of effluent to groundwater is unacceptable and that reasonable methods are available to substantially reduce this seepage.

Recommendation 25

The Panel recommends that biotreatment ponds and spill ponds be required to have linings which will prevent the contamination of groundwater.

6.4 Chlorinated Organic Compounds

6.4.1 Levels of Contaminants

Chlorinated organic compounds include a wide range of potential contaminants which originate from the use of chlorine dioxide bleaching. Celgar was requested by government to measure the levels of chlorinated organics in the water column, sediments and fish at selected locations and to predict the impact on water quality at Castlegar, Birchbank and the Canada-U.S. border. The effects of mill expansion on dioxins and furans, chlorinated phenolics and AOX were considered in detail during the review process.

Dioxins and Furans (See Primer – page 50 – 51)

The dioxins and furans associated with the bleaching of pulp (Figure 12) are primarily 2,3,7,8-tetrachlorodibenzo-p-dioxin (2378 TCDD) and 2,3,7,8-tetrachlorodibenzofuran (2378 TCDF). Both of these compounds, especially 2378 TCDD, have been determined to be toxic to aquatic life, persistent in the environment and prone to bioaccumulation in the food chain.

In the Stage II Report, Celgar predicted that levels of TCDD and TCDF would be in the range of 0.56 - 1.32 ppq in the effluent, well below the current level of detection (10 ppq). In sampling undertaken by the company, dioxins were not detected in water samples. The dioxin 2378 TCDD was detected in fish immediately downstream of the mill but not in sediments. The furan 2378 TCDF was detected in both sediments and fish. Previous sampling has shown significant dioxin and furan levels occurring in mountain whitefish and lake whitefish, leading to consumption advisories. Contaminated white sturgeon and walleye have also been found in Lake Roosevelt.[16] The Ministry of Environment noted that there are significant quantities of primarily 2378 TCDF available to aquatic organisms for bioaccumulation throughout the area downstream to Lake Roosevelt.

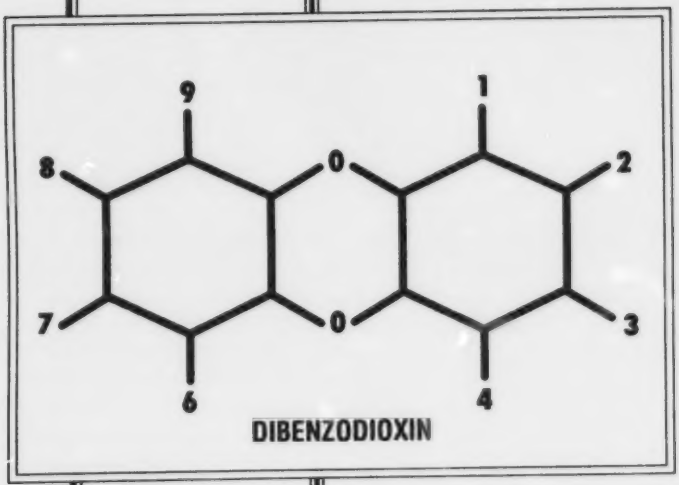
Chlorinated Phenolics

Chlorophenols in general and chloroguaiacols specifically, are the two chlorinated phenolics of principal concern in the

10. Ministry of Environment, op. cit., p. 58.
11. Mr. V. Morandini, Celgar Pulp Company, Technical Hearings Transcripts, p. 1998.
12. Department of Fisheries and Oceans and the Department of the Environment, op. cit. p. 35.
13. Ministry of Environment, op. cit. p. 87.
14. Ibid.
15. Department of Fisheries and Oceans and the Department of the Environment, Addendum on the Celgar Pulp Mill Modernization Proposal, November , 1990, p. 10.
16. Celgar Pulp Company, Stage II Report, Vol. 3, p. 129.

A PRIMER ON DI

Polychlorinated dibenzodioxins (dioxins) and polychlorinated dibenzofurans (furans) are highly persistent compounds with a strong affinity for sediments and a high potential for accumulating in biological tissues. They have been found in all compartments of the ecosystem, including: air, water, soil, sediments, animals and foods. All animals and humans in Canada are exposed to these substances.



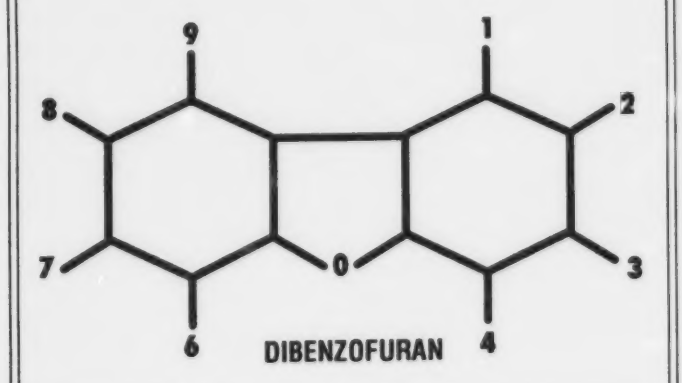
DIBENZODIOXIN

Dioxins and furans enter the environment as complex mixtures from four major sources: commercial chemicals (e.g. pentachlorophenol); incineration; pulp and paper mills that use chlorine bleaching; and both accidental fires and spills involving polychlorinated biphenyls (PCBs, which contain principally furan contaminants).

Both the number of chlorine atoms and their positions on the molecule determine the properties of dioxins and furans. A dioxin molecule contains 2 oxygens (thus dioxin) linked to 2 benzene rings (thus dibenzo). There are 8 potential positions, 4 on the outer part of each benzene ring, where chlorine atoms can attach; these positions are numbered 1 to 4 on the right-hand ring and 6 to 9 on the left hand ring.

If 4 chlorine atoms are attached to the basic dioxin molecule, it is called a tetrachloro/dibenzo/dioxin.

The furan molecule is similar to a dioxin, except it has only 1 oxygen. Like dioxin, there are 8 potential positions where chlorine atoms can attach.



DIBENZOFURAN

It is primarily those dioxins and furans with chlorines in the 2,3,7 and 8 positions that are retained by animals and humans, and which concentrate selectively in body fat and fatty organs such as the liver. Although dioxins and furans can be metabolized and excreted, this is a relatively slow process in humans, with half-lives (time required for breakdown to 50% of initial concentration) of several years reported for some dioxins and furans.

The compound 2,3,7,8-tetrachlorodibenzodioxin (and to a lesser extent, the other dioxins and furans with chlorines located in the 2, 3, 7 and 8 positions) is extremely toxic to mammals, with a wide variation in sensitivity among species. In animals, death results from exposure to amounts ranging from less than one microgram (a millionth of a gram) to a few milligrams (a thousandth of a gram) per kilogram (a thousand grams) of body weight. The bird and fish species tested are more sensitive than most mammals to short-term exposures to dioxins. Longer-term exposure of test mammals to lesser amounts can affect reproduction, cause birth defects, damage the liver and suppress the immune system. Exposure to 2,3,7,8-tetrachlorodibenzodioxin at certain doses (for example 0.1 microgram per kilogram of body weight per day over a lifetime) causes cancer in rodents.

The ecosystem has clearly been affected in several well documented cases. Deaths of animals were noted after accidental exposures at Seveso, Italy and in Missouri, U.S.A. Adverse effects on reproduction of fish-eating birds have been linked to high ambient exposures in the

XINS AND FURANS

Great Lakes and on Canada's West Coast. Malformed embryos and reproductive failure have been observed in fish-eating birds in the Great Lakes.

Studies of human populations indicate that exposure to several milligrams of mixtures of dioxins and furans can lead to a variety of effects on skin, eyes, and sensory and behavioural processes. Exposure of women to several milligrams of furans in contaminated rice oil in Japan and Taiwan may have been responsible for reproductive anomalies and infant mortality. To date, there has been no adequate demonstration that human populations exposed to dioxins and furans have suffered significantly elevated levels of cancer.

Lifetime daily doses of 1 nanogram (one one-thousandth of a millionth gram, i.e. 1×10^{-9} g) 2,3,7,8-tetrachlorodibenzodioxin per kilogram of body weight have no effect on the incidence of cancer in rodents and did not affect fertility, litter size, fetal resorption and organ function in rats exposed through three generations. This dose is considered to be the no-observed-adverse-effect-level for 2,3,7,8-tetrachlorodibenzodioxin, but recall that there is wide variation in sensitivity among species of mammals.

A recent federal-Ontario multimedia study has estimated the average total exposure of Canadian adults and children to dioxins and furans from all pathways. These estimates are based on the average intakes and representative concentrations of these substances in the media to which Canadians are exposed. The average daily Canadian intake of dioxins and furans over a lifetime is estimated to be between 2.0 and 4.2 picograms (one one-thousandths of a nanogram, i.e. 1×10^{-12} g) 2,3,7,8-tetrachlorodibenzodioxin toxic equivalents per kilogram of body weight per day. Virtually all of this intake comes from food.

Based on the no-observed-adverse-effect-level of 1 nanogram per kilogram of body weight per day in rodents and a 100-fold uncertainty factor, it is concluded that human intakes should be below 10 picograms toxic equivalents[a] per kilogram of body weight per day averaged over a lifetime. This value may also be applicable to populations of wild mammals. While the estimated average Canadian exposure to dioxins and furans is below this 10 picogram intake level, persons eating highly contaminated fish in quantities well in excess of the general population norm may approach or exceed the guideline for intake. Wildlife that consumes highly contaminated fish may also be taking in a dose of dioxins and furans that exceeds their tolerable daily intake. Elevated concentrations of these substances in some shellfish near some pulp and paper mills that use chlorine bleaching have necessitated closure of the affected fisheries in order to protect human health. Estimates of dioxin and furan intakes by infants through breast milk are also relatively high. Although medical opinion is that the known benefits of breast feeding outweigh any potential risks, further contamination of human breast milk may lead to significant and unacceptable exposures to dioxins and furans.

Some dioxins and furans are very persistent, and continued release of these chemicals into the environment could unnecessarily prolong exposures, with a resultant increase in the risk to the environment and to human health. Those chemicals which are sources of dioxins and furans are already subject to stringent controls. However, dioxins and furans continue to be released from other sources such as incinerators which employ old technology and from pulp mills that use chlorine bleaching. Large quantities of PCBs (which are a potential source of furans) are currently in storage awaiting the establishment of suitable destruction facilities, which are starting to become available in Canada.

The most significant dioxin sources are the wood preservative pentachlorophenol, municipal incinerators, and pulp and paper mills using chlorine for the bleaching process. Polychlorinated biphenyls (PCBs) are the most significant potential source of furans.

Based on these considerations, the Ministers of the Environment and of National Health and Welfare have concluded that polychlorinated dibenzodioxins and polychlorinated dibenzofurans may enter the environment in quantities which have immediate and long-term harmful effects on the environment and which constitute a danger in Canada to human health. These substances are therefore considered "toxic" as defined under Sections 11(a) and 11(c) of the Canadian Environmental Protection Act.

---

[a]The toxicity of dioxin and furan mixtures in the environment can be assessed by using an internationally accepted system of comparison known as "toxic equivalency factors." The scientific and regulatory communities of eight countries (Canada, Denmark, the Federal Republic of Germany, Italy, the Netherlands, Norway, the United Kingdom and the United States) have agreed upon a standard set of International Toxicity Equivalency Factors that compare the toxicity of the 17 most toxic dioxins and furans found in complex mixtures to that of 2,3,7,8-tetrachlorodibenzodioxin. This system has been broadly corroborated in laboratory studies.

Adapted from:

Canadian Environmental Protection Act, Priority Substances List Assessment Report No. 1: Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans, Environment Canada/Health and Welfare Canada, Ottawa, 1990.

mill effluent. Levels sampled in Columbia River water and fish did not exceed provincial objectives or guidelines for these contaminants.[17] Chlorinated phenols were present in sediment near the mill but concentrations declined rapidly downstream.

Celgar stated that a decrease in the concentration of chlorinated phenolics, particularly chloroguaiacol (Figure 13), is predicted in the effluent and the levels in the water column would rarely exceed the most stringent water quality objective for any individual phenolic compound.[18]

According to the Ministry of Environment, the existing mill, which lacks effluent treatment, generally meets the criteria for chlorinated phenols and the addition of biological treatment and process changes should provide adequate protection for all water uses.[19]

Some concerns were expressed about the potential use of chlorophenol-contaminated wood chips. Celgar responded that quality control of chips received from sawmills ensures that such chips are not utilized. This program is to be extended to the proposed chip suppliers.[20]

Adsorbable Organohalogens (AOX)

AOX provides a convenient means of measuring an array of organochlorine compounds. Detectable levels (>10 ppq) of AOX were present in Columbia River water upstream and downstream of the mill and in the Kootenay River. The levels of AOX in the water column after mill expansion are estimated to average 13 ppb at Castlegar and 101 ppb under worst case conditions. Levels downstream were predicted to be close to the current detection limit of 10 ppq at Birchbank and at the international border. Related extractable organochlorines have been detected in low concentrations in sediments and fish tissue near the pulp mill and immediately above the international border.

Celgar estimated that most of the AOX compounds to be discharged would be high molecular weight chlorolignins, which are in a form less available for biological uptake. Dr. Carey and others noted, however, that AOX is not a good indicator of the sublethal biological effects of pulp mill effluent and that other more biologically available compounds such as dioxins and furans appear to be more accurate indicators.[21]

6.4.2 Fate of Contaminants

The processes by which chlorinated organics affect the aquatic environment are only generally understood. Celgar undertook an evaluation of the fate of organochlorines in the aquatic environment, including sorption of dioxins and furans into sediments and uptake into the biological community. These types of hydrophobic compounds are believed to be largely associated with the discharge and transport of biosolids from the mill. But there is also considerable speculation as to how some of the chlorinated organic contaminants partition between the water and sediments by adsorption-desorption reactions.[22]

Most of the organochlorine contaminants of concern are not readily released into the water column but are transported by solids and bound with sediments where they become biologically available. Dioxin and furan contamination is therefore primarily associated with sediments, bottom dwelling organisms (benthos) and fish which feed on sediments and benthos. Food chain transfer is clearly the most important pathway of accumulation of hydrophobic organochlorine compounds. Celgar's report noted that "it is not possible to determine whether dioxins and furans entered the sediments via deposition of contaminated effluent particles or via sorption of contaminants in solution by sediment particles".[23]

Hydrophylic compounds such as chlorinated phenols were considered to be more soluble and subject to greater dilution and less bioavailability, although this also depends upon particular characteristics of the river system. The Department of the Environment and the Department of Fisheries and Oceans noted that the fate and degradation of such compounds as chlorophenols and other AOX compounds are site specific and likely dependent on physical characteristics and the productivity of the system.[24] While effluent dilution factors are important, sediment sorption and transport mechanisms were considered to be the most relevant factors in determining the fate of chlorinated organic contaminants from pulp mill effluent.

Some criticisms were presented that the fate model used by Celgar may have underestimated current TCDD/TCDF levels in sediments. The Department of the Environment and the Department of Fisheries and Oceans suggested that the model oversimplified the key processes involved in dispersion and bioaccumulation. In particular, they questioned assumptions that were made about the complete mixing of effluent, no deposition, resuspension or burial of particles until Lake Roosevelt, no other losses (e.g. volatilization), no distinction between moving bed loads on the river bottom and bed sediments and no accumulation of biofilms.[25]

Department of the Environment and Department of Fisheries and Oceans scientists also questioned the bioaccumulation assumptions in the food chain model used by Celgar. They argued that, although the model adequately predicts observed levels of TCDD/TCDF in fish, it may be inadequate to predict levels associated with the presence of existing contaminated sediments. Dr. Muir described the complexity of riverine ecosystems and the limited modelling and monitoring data used to determine the fate of organochlorines. There is especially a lack of information on the accumulation of organochlorines at different levels in the food web of the Columbia River.[26]

17. Ibid.; Ministry of Environment, op. cit., p. 61.
18. Celgar Pulp Company, op. cit., p. 148.
19. Ministry of Environment, op. cit., p. 61.
20. Letter to CERP from Celgar Pulp Company Re: Anti-Sapstain Lumber Treatment, Nov. 9, 1990.
21. Dr. J. Carey, Department of Fisheries and Oceans, Technical Hearing Transcripts Vol. 5, p. 1322.
22. Dr. K. Hall, Technical Hearings Document No. 83, p. 2; Dr. D. Muir, Department of Fisheries and Oceans, Technical Hearings Transcripts Vol. 5, p. 1341.
23. Celgar Pulp Company, op. cit. p. 129.
24. Department of Fisheries and Oceans and the Department of the Environment, Technical Hearings Document No. 53, p. 30.
25. Department of Fisheries and Oceans and the Department of the Environment, op. cit., p. 32.
26. Dr. D. Muir, Technical Hearings Transcripts, Vol.5, p. 1340; Dr. M. O'Brien, op. cit., p. 1193.

The levels of TCDD concentration in fish predicted by Celgar, and by the Department of the Environment/ Department of Fisheries and Oceans analyses were determined to be less than or equal to one ppt, which would not add significantly to the already existing contaminant burden in fish.[27] Consideration of the effects of existing contamination in sediments and fish would require more sophisticated models which were not applied to the Celgar project.

The Panel concludes that despite substantial reductions in proposed discharges, the levels of dioxins and furans remain a concern which needs to be addressed by Celgar and government. Existing levels of organochlorine compounds must be reduced. Gradual disintegration of these contaminants in sediments and biota will occur over several decades. The dioxin 2378 TCDD has a degradation half-life of ten years or longer in sediments and equally long in biological tissue.[28] The risks associated with organochlorine compounds warrant action to reduce and eliminate their discharge. Accordingly, as described in Chapter 5, the Panel has recommended actions which will lead to a reduction in chlorine usage, and endorses Celgar's goal of its total elimination.

Recommendation 26

The Panel recommends that the federal Department of Fisheries and Oceans research program into water quality, fish and aquatic resources in the Fraser, Thompson and other rivers be extended in the Columbia River.

6.5 Nutrients and Algal Growth

6.5.1 Nitrogen and Phosphorus Levels

It was estimated that 460 kg/day of total nitrogen and 102 kg/day of total phosphorus will be discharged from the proposed mill in soluble form and associated with biosolids. This is an increase of 136% and 104%, respectively, over current loadings.[29] The soluble forms of nutrients are those which are most available biologically for algae and other aquatic plant growth.

In the proposed mill, 153 kg/day of soluble nitrogen and 51 kg/day of soluble phosphorus will be discharged.[30] Celgar provided data showing that nutrient discharge would contribute only 15% to the daily soluble phosphorus load below the mill and 1.25% to the soluble nitrogen load.[31]

The solubility of nutrient discharges and the nitrogen to phosphorus (N:P) ratio are critical to algal production potential. In the absence of data for large river systems, data were taken from lake systems using total phosphorus and total nitrogen loadings. The Department of the Environment and the Department of Fisheries and Oceans suggested that the in-river N:P ratios used to estimate nutrient limitation may not be representative of the river and that Celgar may not have taken into account accurate effluent loading calculations from similar activated sludge treatment systems.[32]

Chlorate formation from the increased use of chlorine dioxide has been shown to increase algal production in receiving waters. Various scientists noted the uncertainties about the effects of chlorates and their toxicity. In bioassays with juvenile sockeye salmon, lethal and chronic effects have not been observed.[33] It also appears that alterations to the effluent treatment system would be available to remove or reduce chlorate.[34]

Recommendation 27

The Panel recommends that if chlorate is found to pose a water quality problem, the effluent treatment system be modified by a short anaerobic stage (see Recommendation 13).

6.5.2 Algal Growth Potential

Nutrients from industrial discharges such as pulp mills can create major and unpredictable increases in attached algae which in turn present water quality, fisheries and aesthetic problems. Evidence of algal growth on the Columbia River was presented by the Ministry of Environment. Mr. Crozier described the algal growth which has occurred near the Celgar pulp mill and the Cominco fertilizer plant. The growth is sometimes heavy and aesthetically displeasing conditions can occur during late spring when river levels are lower. Exposed attached algae start decomposing after a few days and produce odours which local residents find objectionable.[35] Sloughing of an algal/fungal/bacterial mixture also occurs on the river bottom during late spring.

Evidence was presented on attached algal abundance in Lake Roosevelt. Algal mats of the genus *Cladophora*, a well known indicator of eutrophic (highly nutrient enriched) conditions, have been observed at seven locations in the shore zone of the lake.[36]

Celgar stated that there is the potential that plant growth could be stimulated immediately downstream of the mill during low flow and poor mixing conditions. However, they argue that given the fluctuations in river flow, nutrient concentration would not remain high enough for algal mats to develop.

27. Dr. D. Muir, op. cit., p. 1348.
28. Environment Canada/Health & Welfare Canada, "Canadian Environmental Protection Act, Priority Substance List Assessment Report No.1: Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans", 1990.
29. EVS Consultants, **Impact of Modernized Mill Discharge of Soluble Nitrogen and Phosphorus on the Columbia River**, October 17, 1990.
30. Ibid.
31. Ibid., Table 2, Figures 2,3.
32. Department of Fisheries and Oceans and the Department of the Environment, op. cit., p. 28.
33. Department of Fisheries and Oceans and the Department of the Environment, **Addendum on the Celgar Pulp Mill Modernization Proposal**, November, 1990, p. 5.
34. Ibid.; Mr. H. Hargback, AF-Industrins Processkonsult AB, Technical Hearings Transcripts, Vol. 9, p. 2052.
35. Ministry of Environment, Document No. 55 (Addendum).
36. E. Broch and J. Loescher, **Summary Report on Preliminary Investigation on Eutrophication Trends in Lake Roosevelt with Recommendations for Establishing a Long Term Water Quality Monitoring Program**, Colville Confederated Tribes, 1989.

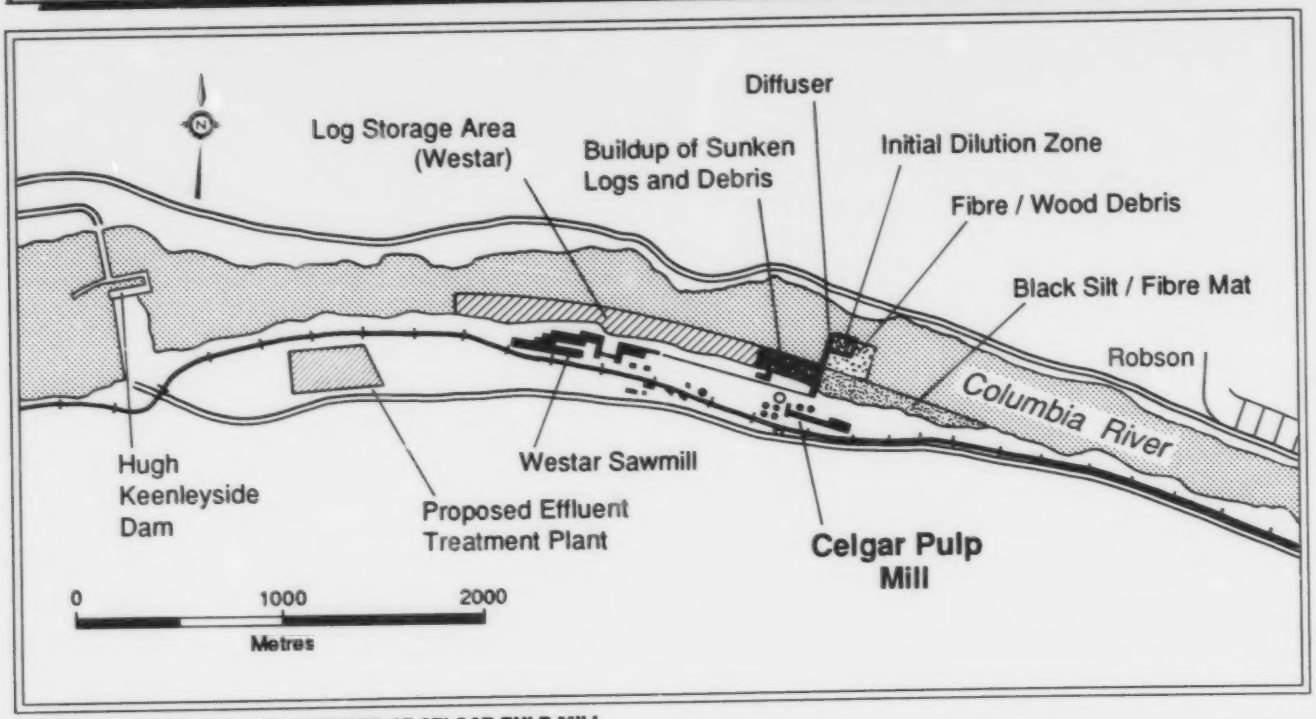


FIGURE 18. FIBRE MAT AND DIFFUSER AT CELGAR PULP MILL.

Representation by provincial and federal agencies pointed to several major uncertainties in estimating the discharge of nutrients and the potential for algal growth. The Ministry of Environment stated that the amount and significance of algal growth are difficult to predict because other factors in the river may determine this growth. Nitrogen has also been identified as a potential limiting factor in algal production downstream of the confluence of the Kootenay River and the projected nitrogen loadings from the proposed mill could stimulate unacceptable algal growth.[37]

The Department of the Environment and the Department of Fisheries and Oceans indicated that major shifts in the composition of attached algal communities can occur when nutrient levels in streams increase above certain low levels and that such potential may exist in the Celgar project. The research presented by Dr. Bothwell showed the significant enhancement of attached algal growth resulting from relatively small additions of soluble reactive phosphate from a pulp mill on the Thompson River.[38] He pointed out that although downstream reaches of the Columbia River may be nitrogen limited, the potential for algal growth will also depend upon the specific character of the algal communities in the river.

Provincial, federal and company officials agreed that the potential for attached algal growth immediately downstream of the Celgar mill requires further evaluation. But there was a distinct difference of opinion as to the appropriate approach to this evaluation. Celgar proposed to undertake pre - and post - modernization attached algal studies within the area from the Keenleyside dam to the confluence of the Kootenay River. The monitoring program would define actual algal communities occurring in the river and the conditions under which algal blooms can occur. This approach was recommended by Dr. Vigers and Dr. Peters.

The provincial and federal governments, however, recommended the use of small-scale nutrient enrichment studies using stream-side flumes to determine the algal production potential. These studies would supplement the proposed monitoring of nutrient additions to the treatment system and algal production in the river.

The Panel concludes that uncertainties exist regarding the potential for excessive algal growth from predicted discharges and that further research efforts, and where necessary remedial actions, are required. This is particularly important, given that the threshold for excessive growth is variable and sensitive to many factors.

Recommendation 28

The Panel recommends that the Integrated Monitoring Program include monitoring of attached algae (species composition, biomass, seasonal growth rate), for at least two years prior to and after full-scale operation of the pulp mill expansion, at various sites in the Columbia River, including one upstream and downstream of Celgar and one below Trail.

37. Ministry of Environment, op. cit., p. 5-6.
38. Dr. M. Bothwell, Department of Fisheries and Oceans, Technical Hearings Transcripts, Vol. 5, pp. 1367-81.

Recommendation 29

The Panel recommends that Celgar be required to undertake an experimental study in replicated riverside troughs to determine:

- ***which dissolved nutrient (nitrogen or phosphorus) is limiting attached algal biomass and production over the growth seasons evident in the natural system; and***
- ***the effects of selected pulp mill effluent loadings on attached algal biomass and production over the growth seasons, using an appropriate control series.***

Recommendation 30

The Panel recommends that the results of in-river monitoring and of trough experiments be used to establish nutrient loading levels for pulp mill effluent (and construction camp effluent, see Recommendation 49) so as to minimize undesirable algae and other aquatic vegetation growth in the receiving waters.

6.6 Fibre Mat

6.6.1 Characteristics

A mat of gel-like silt/fibre material and ash/fibre material occurs on the river bottom adjacent to the Celgar mill, the result of many years of discharges from the mill and loss of fibre from log handling (Figure 18). Deposits of wood debris material also occur immediately upriver of the mill from log storage and handling activities.

At the request of government, Celgar completed a detailed underwater survey of the "fibre mat" and chemical analysis of the constituents of the mat material. The results of this analysis indicated that the material contained less than the "special waste" threshold of 10 parts per billion of dioxins and furans on the basis of Toxic Equivalents.[39] The size of the area covered by fibre mat has also apparently decreased as shown by bottom surveys in 1986 and 1990. The company also proposed measures to minimize the loss of log debris. They noted that the effluent from the proposed mill will contain little fibre or fly ash, and that woodroom technology will lessen deposition of further bark residue, so that buildup of this material will no longer occur.

Government scientists and technical consultants advised that the levels of organochlorines associated with the fibre mat and their uptake by biological organisms are not well understood. Some suggested that the analyses to date may not have provided a representative indication of dioxin and furan concentrations.[40] No information was provided on the levels of contaminants within the benthic community around the fibre mat although pollution-tolerant invertebrates do inhabit the area. However, sport fish sampled near the mill had significant levels of dioxins (10.5 ppt 2378 TCDD).[41] Dioxins and furans are persistent contaminants with high bioaccumulation rates and their interactions with fibre mat material remain uncertain.

6.6.2 Remedial Actions

Some representations indicated that the existing fibre mat would slowly dissipate once the effluent is improved.[42] Others suggested that remedial actions would be necessary to reduce the function of this mat as a trap for contaminants. In general, however, technical participants agreed that:

- ongoing sampling of the interstitial water, sediments and organisms of the fibre mat should be undertaken;
- further studies should be undertaken to evaluate the feasibility of removal or management of the fibre mat, although Celgar and others argued that this should be contingent on the results of ongoing monitoring; and
- action should be taken to minimize the addition of wood debris from log storage and handling.

The major remedial options are natural recovery and dredging. Natural recovery is reported to be a slow process while dredging could involve the release of many toxic compounds, including methane and sulphide.[43]

The Panel concludes that insufficient information is available on the potential effects of removal or treatment of the fibre mat deposits and that natural degradation and recovery should be monitored as a basis for determining the need for future remedial action.

Recommendation 31

The Panel recommends that Celgar be required to undertake ongoing monitoring and reporting of the extent and toxicity of the fibre mat, as well as chlorinated organics within interstitial waters, sediment and bottom-dwelling invertebrates, so as to determine the degree of natural degradation and recovery after project construction, and whether remedial action is required.

6.7 Fish and Wildlife

6.7.1 Fish Species and Habitat

Limited information is available on the fish species in the Columbia River and their habitat utilization. Inventory data are currently being collected by B.C. Hydro. There are ten sport fish species known to inhabit the river, including rainbow trout, brook trout, bull trout, chinook salmon,

39. Toxic Equivalent (TEQ) is an expression of the potential toxicity of dioxins and furans. TEQ is calculated by multiplying concentrations of individual dioxins and furans by a factor, which represents the toxicity of the compound relative to 2378 TCDD, and then summing these values for all dioxins and furans.
40. Department of Fisheries and Oceans and the Department of the Environment, op. cit., p. 27.
41. Mah, F., et al., Dioxins and Furans in Sediment and Fish from the Vicinity of Ten Pulp Mills in British Columbia, Environment Canada, 1989.
42. Dr. J. Sprague, Technical Hearings Document No. 58.
43. R. Kistritz & A. Sobolewski, Report on Fibre Mat Research, Oct. 1, 1990.

kokanee, mountain whitefish, lake whitefish, walleye, burbot and white sturgeon.[44]

Many of the sport fish utilize the entire river from the Keenleyside dam to Lake Roosevelt. Some species, such as walleye, migrate upstream from Lake Roosevelt in the early spring and congregate at the tailrace of the dam. Spawning and rearing habitat occurs throughout the mainstem of the Columbia River and its tributaries. Norns Creek, 5 km downstream from the mill, is a particularly important fish habitat, especially for spawning and early rearing of some sportfish (e.g. kokanee, rainbow trout).

Fish habitat has been altered principally by flow regulation at dams, deposition of wood debris from log transport and processing, fibre mat build up from the pulp mill and sawmill operations and from slag deposition from smelter operations at Trail. Ministry of Environment biologists described the problems in determining and maintaining fish habitat when changes in the flow regime severely reduce the available area of habitat. They stated that fish populations have declined as a consequence of industrial developments.[45] One of the major goals is to improve the consumptive quality of all sport fish and to eliminate the current real and perceived effects of health problems associated with consumption of fish from the river.

6.7.2 Effects on Fish

Acute Effects

Celgar stated that, although no actual data from similar mills are available to confirm that mill effluent will not be acutely toxic (i.e. 96 hr LC_{50} test) prior to the addition of cooling water, knowledge of similar treatment systems and proposed discharges is expected to ensure that this level of protection is met. The prediction of a non-acutely lethal effluent prior to dilution was supported by federal and provincial agencies and various technical consultants, including Dr. Sprague and Dr. McCleay. The Department of the Environment and the Department of Fisheries and Oceans stated that the treatment system, operated diligently and properly maintained, would not produce an acutely toxic effluent and would be in compliance with the federal pulp and paper regulations.

Various scientists also recognized that the LC_{50} acute toxicity test provides only a crude measurement of contaminant effects. The test measures the substances which cause rapid death and not the subtle effects of accumulative toxicants such as dioxins. Nor do laboratory tests replicate field conditions and important food chain interactions. Dr. Schindler, for example, noted that conclusions regarding the non-detectability of dioxins and furans in the water column may not be relevant for such contaminants with high bioconcentration rates in sediments and the food chain. More elaborate methods of testing for biological effects are therefore required.

Sublethal Effects

Celgar described the sublethal responses of aquatic organisms to pulp mill effluent. They stated that constituents of effluent that affect growth and development of fish may not be completely removed by secondary treatment but concentrations causing these effects will not occur beyond the initial dilution zone (IDZ). Dr. McLeay however, offered the view that:

> Assuming that concentrations of bio-treated effluent ranging from 1 to 2 % (effluent in water, volume to volume basis) exist within the receiving waters under low flow (<142 m^3/s) conditions prior to complete mixing of the mill's discharge, the possibility of sublethal toxic effects beyond the IDZ cannot be dismissed.[46]

The Department of the Environment and the Department of Fisheries and Oceans commented:

> ... there may be potential for sublethal effects within the effluent dilution zone. The likelihood of this potential being expressed however is unknown particularly as the pattern of effluent dispersion is not clearly defined and the distance to complete mixing is variable. The potential for sublethal effects to occur depends to a large extent on the period of fish residence and the length of their exposure in the zone of incomplete mixing.[47]

The Panel heard results of the latest research in Canada on the transport mechanisms of organochlorines, their fate and persistence in the environment, and the serious biological responses of fish to these pollutants, even at very low concentrations.

Studies of other pulp mills have shown that particularly hydrophylic compounds such as chlorophenols, occur in detectable amounts in fish long distances downstream from the source. For example, Dr. Lockhart noted that chloroguaiacols originating in pulp mills in Prince George and Quesnel have been observed in the Fraser estuary, up to 800 kilometers downstream. Dr. Carey described the La Tuque study in Quebec where discharges from a mill (with old technology and primary treatment only) were correlated with physiological changes in fish up to 96 km downstream. Dr. Schindler also described the long-distance transport of dioxins and furans in the Slave River.

Much of the research in North America on the sublethal effects of treated bleached kraft pulp mill effluent has shown that various physiological and biochemical effects can occur at thresholds down to 1% effluent within receiving waters. Swedish research indicated that effects may occur at concentrations as low as 0.1%. This research led to similar studies in Canada where results did not confirm these findings. The differences have recently been explained in terms of the presence of other sources of contaminants, lack of secondary treatment, start-up conditions and the different research approaches in Scandinavia.[48]

---

44. In this report, the common names for fishes have been taken from the American Fisheries Society, A List of Common and Scientific Names of Fishes from the United States and Canada, Special Publication No. 12, 4th Edition, 1980.
45. B.C. Ministry of Environment, Technical Hearings Document No. 55, p. 83.
46. Dr. D. McLeay, op. cit.
47. Department of Fisheries and Oceans and the Department of the Environment, Addendum on the Celgar Pulp Mill Modernization Proposal, November, 1990, p. 12.
48. Dr. J. Carey, op. cit.; Dr. J. Sprague, op. cit.

In recent Canadian studies, small concentrations of dioxins, furans, chlorophenols, chloroguaiacols and other chlorinated organic contaminants have been associated with various physiological responses in fish such as induction of liver enzymes; haematocrit changes related to red blood cell content; disruptions to sex hormones and reproduction; and decreased competence of the immune system and thereby disease resistance. Dr. Servici and his colleagues, for example, presented the results of research on the effects of non-lethal, bio-treated pulp mill effluent on Fraser River fish.[49] Using measurements of interrenal nuclear diameter, related to stress hormones in fish, he showed that although life cycle stages were normal, there was a dose-dependent stress response in fish which may compromise disease resistance. He found that the threshold for liver enzyme induction was about one part per trillion TCDD TEQ. Their research also compared bioconcentration of dioxins and furans in juvenile salmon exposed to effluent in the laboratory versus in the river. Their findings suggested that bioaccumulation was primarily via the food chain, and that direct uptake from water was minor.

Dr. Carey described the disappearance rates of certain organochlorines and their variability between river systems.[50] He presented the concept of "half distance", or the distance downstream where the concentration decreases by one-half. Studies showed that half-distance of chlorophenol concentrations in water varied from 34 to 100 km, while that for AOX concentrations required about 300 km. Since biological effects had apparently disappeared by 96 km, it was concluded that AOX may be a poor predictor of sublethal responses. Moreover, the persistence of these compounds appears to be highly dependent on the flow regime. Dr. Carey suggested that the disappearance rates are inversely proportional to the flow in a river system.

The Panel concludes that the predicted loadings of organochlorine compounds, while a concern, are not expected to significantly add to the current burden of contaminants in fish. Incomplete mixing in the section of the Columbia River downstream to the Kootenay River, however, could result in sublethal stress on fish in the vicinity of the pulp mill during certain low flow conditions. The numbers and species of fish affected are unknown, as is the degree of sublethal effects. It is essential that the proposed Monitoring Program focus on identifying and managing these effects, and that it translate the results into appropriate action.

6.7.3 Effects on Wildlife

Information was also presented to the Panel on the accumulation of organochlorines in wildlife in relation to pulp mill discharges. Concerns for migratory birds were based on findings of elevated dioxin and furan levels in eggs of fish-eating birds breeding near coastal kraft pulp mills and on the correlation of sublethal health effects in embryos of great blue herons.[51] Dr. Whitehead presented the results of studies by the Canadian Wildlife Service which showed a possible relationship between high levels of 2378 TCDD in great blue heron eggs and failure to produce young or to fledge young.[52] High levels of dioxins and furans were also reported in fish-eating diving ducks and bald eagle eggs and these have been reflected in certain physiological responses although links to effects on populations remain uncertain.

Dr. O'Brien referred to studies on the lower Columbia River indicating significant reproductive failure in bald eagle populations and elevated concentrations of organochlorines, notably DDE (a breakdown product of DDT) and PCB.[53] She also described the existing contaminant burdens in other species of wildlife such as mink and otter and the cumulative effects of discharges of chlorinated organics into the Columbia River.

No data were available on the Columbia River between Castlegar and the border regarding contaminants in wildlife. Given the available evidence on the bioconcentration of pulp mill contaminants at higher levels in the food chain, some sublethal effects on wildlife are probable.

The Panel concludes that better information is needed on the biological accumulation of organochlorine contaminants in birds and aquatic wildlife in the Columbia River. Comparative studies of migratory wildlife in the Columbia system, building upon studies undertaken on the coast, would provide an indication of bioaccumulation occurring in wildlife. Cooperation with U.S. scientists on contaminants in aquatic mammals is also essential to better understand the state of wildlife on the river.

Recommendation 32

The Panel recommends that the Canadian Wildlife Service undertake studies of the accumulation of contaminants, including chlorinated organics, in selected species of migratory birds in the area affected by the mill.

Recommendation 33

The Panel recommends that Canadian and United States agencies undertake coordinated studies of the accumulation of contaminants, including chlorinated organics, in amphibians and aquatic mammals in the area affected by the mill.

6.8 Recreation

6.8.1 Recreational Uses

The Columbia River provides a variety of sport fishing and boating activities for residents of Canada and the United States. Celgar presented a review of the available information on the recreational uses of the river. Surveys of fishing effort indicate that 475 angler days per month occur during the late summer months on the river between the Keenleyside dam

49. Dr. J. Servici, Department of Fisheries and Oceans, Technical Hearing Transcripts, Vol.5, p. 1325-1336; Servici, J. et al., "Effects of Bio-Treated Bleached Kraft Mill Effluent on Fingerling Chinook Salmon," Presented to the Canadian Symposium on Water Pollution Research, Burlington Ontario, February 15, 1990 (Updated October 9, 1990).
50. Dr. J. Carey, op. cit. p. 1311.
51. Department of Fisheries and Oceans and the Department of the Environment, Technical Hearings Document No. 53, p.40.
52. Dr. P. Whitehead, Department of the Environment, Technical Hearings Transcripts, Vol. 5, pp. 1427-1433.
53. Dr. M. O'Brien, Technical Hearings Document No. 60.

and the border, 60% of which are boat anglers and the remainder shore anglers.[54] The section of the river between the dam and Kootenay River is a popular fishing area.

Recreational boating is also significant, including extensive boat touring between Lower Arrow Lake and Lake Roosevelt. The Columbia River provides a 500 km recreational waterway between Grand Coulee dam and Revelstoke dam. Boating participation probably involves over 10,000 person-days annually. The number of pleasure craft which have passed through the locks of the Keenleyside dam, for example, have been in the range of 100-200 annually.

The effects of mill expansion will improve some conditions for recreational users of the river by reducing the current pollution loading. Toxicity and aesthetic characteristics of the effluent and emissions will decline but not be eliminated. As noted in preceding sections, some uncertainties remain as to effects on attached algal populations, sublethal stresses on fish populations immediately downstream of the mill and the persistence of existing contaminants in the fibre mat and sediments.

Tainting of fish as a result of pulp mill effluent is not expected, except perhaps under low flow and incomplete mixing conditions. However, dioxin and furan concerns, real and perceived, still limit the fishery.

Ministry of Environment staff noted that many people are now wary of eating walleye because of the concern raised by the health advisories and this affects local fishing participation.[55]

6.8.2 Health Advisories

Public concerns about water quality and recreational use of the Columbia River have centered on dioxin and furan levels in two species of whitefish which exceeded guidelines for human consumption.[56] The State of Washington noted that the Celgar mill is the primary source of dioxin and furan contaminants in Lake Roosevelt.[57]

The three health advisories which have been issued are:

- May 1988, Health and Welfare Canada, advisory limiting consumption of lake whitefish to 40 grams per person per week ;
- June 1990, Ministry of Environment and Ministry of Health, advisory recommending consumption of mountain whitefish be limited to 205 grams per week;
- August 1990, Washington State Department of Ecology, limited advisory recommending that children less than 4 years age or weighing less than 40 pounds (18 kg) not eat lake whitefish.

The health effects of pulp mill discharges were a major concern to participants in the review process. Given the accumulation of contaminants in sediments and organisms, the potential for further advisories is possible. However, reduced organochlorine loading will minimize this possibility.

Environmental and health agencies in British Columbia and Washington are anxious that a program to reduce current dioxin and furan discharges be initiated. The U.S. Environmental Protection Agency stated that the proposed discharge limits will help to resolve many of the health concerns of Lake Roosevelt residents. [58]

The Panel recognizes the potential recreational opportunities of the Columbia River and the importance of removing fish consumption advisories. Accordingly, recommendations are presented in Section 5.3 which address the discharge of pollutants and monitoring of the effects on the aquatic environment.

6.9 Log Transport and Handling

The transport and handling of logs in the Columbia River has been a source of considerable build-up of wood debris and other organic material which degrades water quality and fish habitat. The Stage II Report requested a review of the alternatives to water storage and handling of logs.

Celgar identified four options :

(i) water storage and handling
(ii) exclusive land-based log storage
(iii) land-based storage
(iv) off-site wood chipping.

It was estimated that 512,476 logs would have to be handled at the site to provide the 267,000 m^3 of pulpwood to be processed in the woodroom. Estimates of the quantities of logs arriving by water and by truck were not available. The major concern is that water storage and handling, and particularly unloading of logs from trucks, result in the loss of fibre and increased organic solids on the river bottom. The apparent disadvantage of the land-based storage and handling is the additional capital and operating cost, especially if a relatively small volume of logs is being handled. The mill site also has little available space for land-based systems.

Celgar indicated that they would be minimizing the loss of fibre by limiting water storage to no longer than two weeks on average and by the use of bundles in receiving logs by truck. They also stated that they would be assessing the options in further detail.

The Ministry of Environment indicated that it would be willing to accept historical levels of water-based log transport and storage but would not accept the unnecessary introduction of logs transported by truck into the river.[59]

There are tradeoffs associated with the choice between water transport and truck transport of logs. The undesirable effects of both methods would be felt if logs are delivered by truck and then dumped into the river. Various measures could be taken to avoid adding truck-delivered logs to the river by controlling the timing of delivery to the woodroom. Other mitigation measures can be adopted to minimize the effects of logs transported by water. These include species grading and sorting prior to delivery, bundle towing, barge transport, limiting water storage periods and debris catchment at the log feeder and decks.

The Panel concludes that the resulting fibre losses from re-

54. Celgar Pulp Co., Additional Information, August, 1990.
55. Mr. J. Hammond, Ministry of Environment, Technical Hearings Transcripts, Vol. 8, p. 1782.
56. Ministry of Environment, Technical Hearings Document No. 55, p.46.
57. State of Washington Department of Ecology, **Proposed Effluent Limitations for Dioxin and AOX**, July, 1990, Technical Hearings Document No. 62.
58. Letter to CERP from Mr. T. Wilson, Office of Water Planning, U.S. Environmental Protection Agency, October 4, 1990.
59. Ministry of Environment, op. cit.

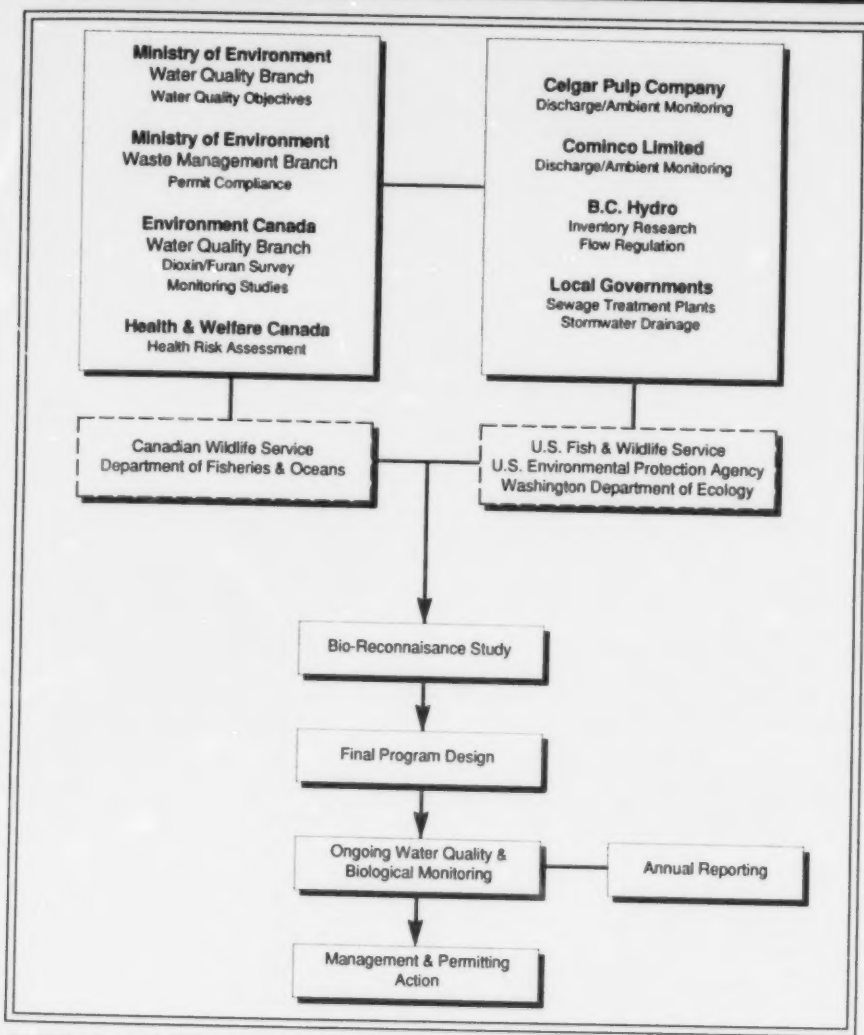


FIGURE 19. RECOMMENDED COLUMBIA RIVER INTEGRATED MONITORING PROGRAM.

opening the woodroom and log transport and handling could have a significant effect on water quality. The introduction of truck-transported logs into the Columbia River at the mill site would be an unnecessary addition of organic material and measures should be undertaken to minimize fibre deposition to the river.

Recommendation 34

The Panel recommends that Celgar and the federal and provincial governments jointly develop log storage and handling procedures for minimizing the deposition of wood debris and fibre into the aquatic environment.

6.10 WATER QUALITY MONITORING

6.10.1 Integrated Monitoring Program

Details were provided on the proposed Integrated Monitoring Program between the major industrial users of the river - Celgar, Cominco and B.C. Hydro.[60] The major elements are shown on Figure 19. The purpose of the program is to provide systematic data on the water, sediments and biota of the Columbia River in order to meet the information needs of the industry participants and government agencies in managing the aquatic environment. In addition to cost savings, this approach has the advantage of providing a common monitoring scheme which avoids duplication of effort by the participants.

Sampling procedures have been designed to fulfill the requirements of various provincial and federal water quality management objectives and to avoid duplication in monitoring efforts. The program will include data collection on contamination in sediments, bottom-dwelling organisms and fish in order to define causal relationships between components and variability between reaches. The intent is to select indicator organisms which can provide a cost-effective basis for trend analysis.

Formal agreement on the details and cost sharing of the program was not finalized by the time of the Panel's hearings. However, Celgar and the other participants indicated their support in principle for the program.

The Integrated Monitoring Program was also supported by U.S. agencies, although it does not currently extend across the border. The Colville Tribes, for example, emphasized "the need for an extensive transboundary study of planned discharge constituents and their environmental inputs".[61] Representatives from the State of Washington described the lack of fundamental data on pollutants in Lake Roosevelt.[62] Currently, liaison occurs on an ad hoc basis along with some exchange of technical data. The State of Washington

60. Ministry of Environment, **Columbia River Integrated Monitoring Program** (prepared by Sigma Engineering Ltd.), September, 1990.

61. Letter to CERP by the Colville Confederated Tribes Re: Stage II Reports, October 24, 1990.

62. Mr. A. Johnson, Washington State Department of Ecology, Technical Hearings Transcripts, Vol. 5, p.1281.

Department of Ecology expressed an interest in cooperating with the proposed monitoring program. The U.S. Environmental Protection Agency (EPA) submission also supported further actions to reduce contaminant loadings. The establishment of maximum daily loading limits by the EPA for discharge of dioxins into the Columbia River emphasizes the need for a coordinated international approach.[63]

The Panel concludes that the Integrated Monitoring Program is the central mechanism for improving the information base on the aquatic environment and managing the effects of human activities. This program reflects the goodwill and commitment of government and industry to cooperate in addressing the comprehensive and cumulative aspects of environmental management. Further efforts are urged to involve U.S. agencies and local government.

The Panel also concludes that the participants in the Integrated Management Program should initiate research into wildlife concerns using a similar approach which focuses on key indicators. These data can provide the basis for the eventual development of comprehensive environmental policies for this section of the Columbia River. There is a long history of international cooperation regarding the Columbia River, which could form the basis for a Canada-United States commitment to environmental protection for this mighty river, unbounded by borders.

Recommendation 35

The Panel recommends that the federal Department of the Environment, including the Canadian Wildlife Service, and the Department of Fisheries and Oceans, become direct participants in the Integrated Monitoring Program.

Recommendation 36

The Panel recommends that the federal and provincial governments take measures to secure the participation of the U.S. Environmental Protection Agency and the Washington State Department of Ecology in the Integrated Monitoring Program.

6.10.2 Monitoring Methods

Biological Testing

Biological tests are used to monitor effluent quality and the receiving environment. Specific details of proposed monitoring methods were not provided by the company or government.

Recent developments in biological testing have involved the use of a wide range of rapid biological tests to assess the degree of toxicity of process streams and effluent discharges. The federal Department of Environment has prepared a set of standardized methods for biological testing in the aquatic environment.[64] The revised federal Pulp and Paper Effluent Regulations require periodic checks to confirm that effluent is not acutely lethal to rainbow trout or the freshwater invertebrate *Daphnia magna*. In addition, rapid (i.e. 15 minutes) biological tests using luminescent bacteria, prolonged exposure to sublethal toxicity tests such as 7-day tests for survival and growth of fathead minnows, and for survival and reproduction of the freshwater invertebrate *Ceriodaphnia dubia* may be required. Dr. McCleay suggested that certain of these tests could be used by Celgar to closely monitor in-plant process streams and the acid, alkaline and general sewers discharged to the treatment system.

On-site capability for measuring and monitoring acute toxicity can provide for quick and inexpensive appraisal of effluent quality and early response to plant upsets. Rapid biological tests can provide the basis for regular daily checking of inflows to and outflows from the effluent treatment system. The Department of the Environment and the Department of Fisheries and Oceans stated that tests such as *Microtox* require baseline reference values to permit assessment of acute toxicity and that continuous instream pH and conductivity are normally used to indicate upset or spill conditions.[65] However, other evidence indicates that biological measures provide much better indicators of toxic conditions and there is in fact substantial published and unpublished evidence of high correlations between *Microtox* and 96hr LC_{50} bioassay test results. Other rapid assessment sublethal toxicity tests are also available.

Biological tests measuring lethal and sublethal effects are clearly evolving as useful tools for on-site measurement of toxicity. The conventional 96hr LC_{50} test can now be supplemented with a host of tests which are more suitable for quick measurement and better able to reflect the complex effects on the aquatic environment. There is an obvious need to be selective in the use of biological tests and to ensure that trained staff are proficient in conducting such tests.

Effects Monitoring

The draft "Guidelines for Environmental Effects Monitoring at Pulp and Paper Mills", prepared by the federal Department of the Environment, was provided to the Panel. According to government officials, these guidelines provide a set of core components which could be incorporated into the Integrated Monitoring Program, although they await completion of the federal Environmental Effects Monitoring Program and their future application to the Celgar project remains unclear.

Some experts noted that detailed monitoring data are often unnecessary and that the focus of data collection should be on a few key indicators. Dr. Peterman, for example, suggested that statistical power analysis can assist in the selection of variables for monitoring such that the data provide conclusive results about environmental change.[66] Dr. Sprague also commented that monitoring need not be complex, detailed or expensive provided that effective measurement variables are selected.[67] Dr. Vigers also distinguished between "need to know" and "nice to know" information from monitoring programs.

63. Mr. T. Wilson, op. cit.
64. McLeay D., et al., **Status of Development, Environment Canada Biological Test Methods**, November, 1990.
65. Department of Fisheries and Oceans and the Department of the Environment, **Addendum on the Celgar Pulp Mill Modernization Proposal**, November 13, 1990.
66. Dr. R. Peterman, Technical Hearings, Vol. 9, p. 2024.
67. Dr. J. Sprague, op. cit.

There appeared to be general agreement amongst scientists that many of the water quality parameters collected are not always needed for decision making purposes and that monitoring should focus on selecting the important indicators of change in the environment.

The Panel therefore concludes that comprehensive monitoring of process streams, effluent discharges and receiving waters is essential to mitigating impacts and reducing uncertainties, but that such monitoring should be designed to produce conclusive measures which can assist management decisions. Biological testing methods offer many advantages in terms of warning of process upsets, measuring sublethal effects, timeliness of results and cost effectiveness. These should be incorporated into the program.

White Sturgeon fishing on the Columbia River.

Recommendation 37

The Panel recommends that the final design of the Integrated Monitoring Program include only those physical, chemical and biological indicators which will have a high probability of detecting change, and which can be used to prescribe action to manage and abate adverse consequences.

6.10.3 Environmental Reporting and Consultation

Community groups expressed interest in regular public reporting on environmental management of the Celgar mill. In response, Celgar stated that they are prepared to participate in a municipal environmental performance panel and suggested representation from the health community, local education, municipal council and wildlife associations.[68] Members of the PPWC union proposed a similar environmental impact monitoring and reporting committee.[69]

Improved public reporting and accountability was a key theme of the representations by the Valhalla Society, the Kootenay Coalition for an EARP and various individual presentations.

The Panel concludes that various means of public consultation are needed to improve public awareness, trust and understanding. Celgar, public groups and local government expressed support for better methods of communication with the public.

Recommendation 38

The Panel recommends that the Integrated Monitoring Program require an annual report summarizing the results and informing the public of environmental conditions and trends in the Columbia River system.

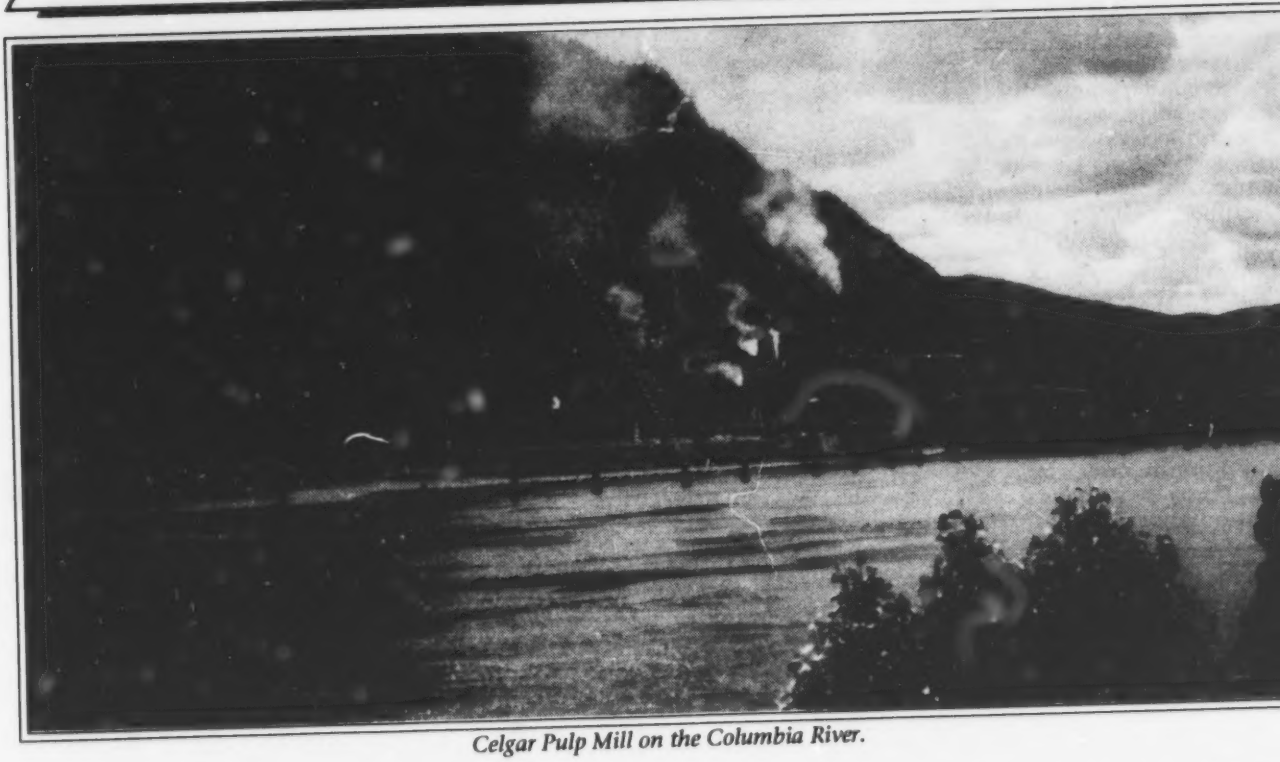
6.11 Enforcement and Compliance

The Ministry of Environment stated their commitment to establishing rigorous conditions of approval and enforcing compliance with such conditions. They indicated that violations to waste management permits would be subject to prompt legal action. But they also pointed to examples of cooperation from Celgar staff when problems have arisen in the past and the improved spill reporting experience in recent years.

As noted in Chapter 5, representation by environmental groups and individuals pointed out the poor record of compliance by the existing mill. References to inaccurate or inoperative monitoring equipment and the requirements to take grab samples when automated monitoring was not working reiterated the need for continued vigilance in measuring plant performance.

The Panel concludes that historical practices of variance to and non-compliance with effluent discharge permits are unacceptable and future inspection and enforcement should be rigorous. As described in Section 5.6, a new approach to environmental management must be required for the new mill, one which displays corporate and government responsibility for avoiding, minimizing and responding to environmental problems.

68. Mr. L. Parnell, Community Hearings Transcripts, Vol. 8, p. 1822.
69. Mr. C. Him, Technical Hearings Transcripts, Vol. 8. p. 1822.



Celgar Pulp Mill on the Columbia River.

Attached algae downstream from Castlegar sewage treatment plant, April 20, 1990.

Chapter 7: Air Quality Issues

7.1 Climate and Terrain

Winds and air quality in the Castlegar area are heavily influenced by climate and terrain. Cold winters and dry summers are typical of the continental climate of the area. Temperature extremes range from -30° C to 40° C. The surrounding terrain channels air flows along the river valleys from the south, west, and northeast (Figure 20). The physical nature of the valley causes a general reduction in wind strength and tends to isolate the valley bottom from the upper atmosphere.[1]

The prevailing wind direction is northerly at the airport and easterly at the Keenleyside dam, although winds from the opposite direction blow with almost equal frequency.[2] A high frequency of calms (30.1% annually) is reported at the airport while a low frequency occurs at the dam and at the Castlegar hospital. Under certain conditions, winds blow in opposite directions in different parts of the river valley near Castlegar.

Inversions are created when the mixing and vertical rise of stable, colder air is suppressed by an upper layer of warmer air. Persistent inversions can occur during the winter in the Columbia valley when cold air is trapped in the valley bottom. Summer inversions also arise when stagnant, high pressure areas occur in the valley bottom. Nocturnal cooling further contributes to air stability and inversion potential.

Celgar's Environmental Impact Assessment described the poor ventilation which occurs in the winter in Castlegar, especially during the presence of Arctic air masses. They noted that the complex terrain and resulting complex air flows make the application of standard Gaussian dispersion models difficult.

7.2 Dispersion of Emissions

Celgar was requested to undertake dispersion modelling of the proposed air emissions. Effects on ambient air quality were evaluated using U.S. EPA computer models. This included the Rough Terrain Diffusion Model for predicting air quality at locations in the Columbia River valley above the lowest stack, and the Mobile Point Source Model with terrain adjustment for locations below the lowest stack top. In addition, an Industrial Source Complex Short-Term Model was used for area sources such as the effluent lagoon. Celgar's consultants described the scope of the modelling:

> In order to carry out the entire air quality analysis for the Celgar modernization project, three models, involving 21 different scenarios for the various emissions, 1,518 receptors, approximately one year of meteorological data for 24 hours of each day, and several emission sources required the total calculation of about 1.3 billion calculations for ambient air quality on Cirrus's computers.[3]

Celgar and their consultants disagreed with the terms of reference for the modelling work, particularly the input criteria and assumptions prescribed by the Ministry of Environment. They argued that the model which was required to be used produced results which were not realistic because it failed to take account of "terrain enhanced plume dilution" and because of the overly conservative atmospheric stability criteria. The prescribed approach assumed a 43% occurrence of stable conditions in the valley while the EPA criteria, preferred by Celgar's consultants, normally assumes a 27% occurrence of these conditions. These differences were considered to significantly affect the frequency at which the plume would impact on elevated terrain.

Mr. Hovind argued that significant reductions (in the order of 10 to 15 fold) in plume concentrations could occur over intervals of one hour or more when the plume interacts with surrounding terrain.[4] The implication is that the analysis which was required to be undertaken is very conservative and overestimates predicted concentrations of contaminants.

The Ministry of Environment stated that they require the use of conservative dispersion models, particularly when data bases are not complete. They found deficiencies in the analysis originating from a lack of site specific data, including insufficient information on the meteorological and dispersion peculiarities associated with the area.[5] They also argued that the impact assessment should have considered, in more detail, the effects of background air quality, including other sources of SO_2. They also suggested that the worst case scenario did not sufficiently consider the effects of equipment shutdowns for maintenance.

Other representation expressed doubts about the reliability of dispersion models to predict air quality in these types of complex geographic and meteorological circumstances. Dr. Murray indicated that winds in Castlegar are often light and below the lower calculation level of the Gaussian models which were used.[6] He questioned the value of extensive modelling when so many uncertainties occur in the predictions. Dr. Thyer also questioned whether dispersion modelling was really valid given the complex topography and wind patterns of the area.[7] Both Dr. Murray and Dr. Thyer suggested the use of existing monitoring data associated with the present mill to formulate predictions about pollutant concentrations and to validate the models.

Despite the considerable effort and expense in applying the computer models of air emission dispersion, there is limited certainty that the analyses reflect actual conditions at the mill site. Most notably, little information was provided on the current emission patterns under different weather

1. Ministry of Environment and Parks, "Castlegar Air Quality", 1987, p. 12.
2. Celgar Pulp Company, Environmental Impact Assessment, December, 1989, p. 63.
3. Mr. R. Nogami, Technical Hearings Transcripts, Vol. 10, p. 2139.
4. Mr. E. Hovind, Technical Hearings Transcripts, Vol. 10, p. 2145.
5. Ministry of Environment, Technical Hearings Document No. 55.
6. Dr. F. Murray, Review of the Ministry of Environment's Presentation at the Technical Hearings, Nov. 11, 1990.
7. Dr. N. Thyer, Technical Hearings Transcripts, Vol. 10, p. 2313.

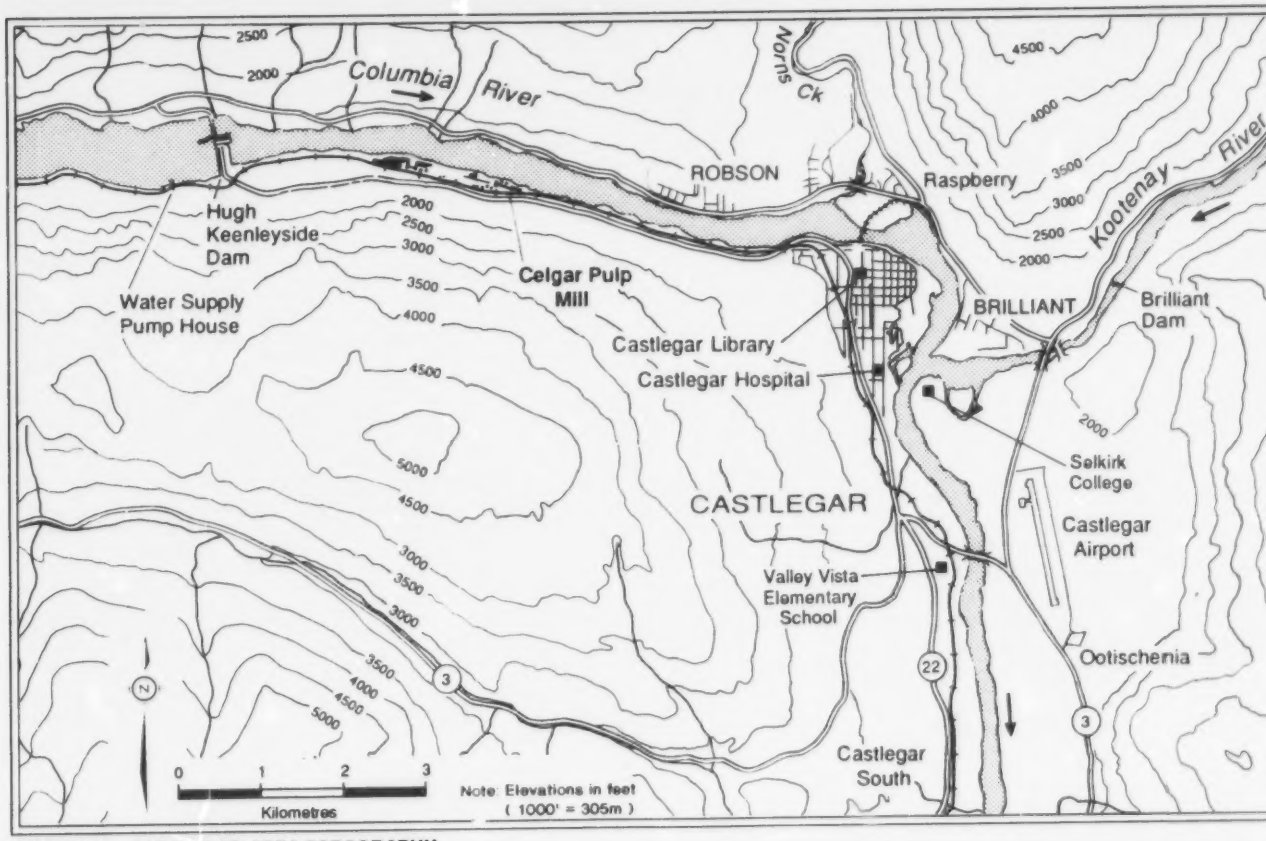


FIGURE 20. CASTLEGAR AREA TOPOGRAPHY.

conditions. These could have been better evaluated using existing data and site specific field studies.

The Panel concludes that the dispersion modelling provided unreliable estimates of potential concentrations of ground level air quality and that too much reliance was placed on theoretical models to predict air quality effects. The use of existing data and observations of current air emissions behaviour would have provided a more reliable basis for impact assessment and model validation. The program for further assessment and management of air dispersion should focus on careful monitoring of air quality conditions and responsive management, as outlined in section 7.8.

7.3 Ambient Air Quality Effects

Celgar presented the results of the air dispersion modelling in terms of effects on ambient concentrations of contaminants. Air pollution levels were evaluated according to two levels of provincial standards. Level A was the reference level established by the province representing maximum desirable standards while Level B represented interim or maximum acceptable standards. The federal government has similar air quality objectives.

The modelling was required to consider 99 percent or higher of the proposed emission rates, and some discussion focussed on whether emissions during maintenance shutdowns should be excluded from this analysis. The mo were required to predict the worst case maxim concentrations, under normal operating conditions, of pollutant at each receptor location, for the modelled period (1 hour, 24 hours), the maximum extr concentrations which were predicted, and the frequenc exceedances of Level A and Level B objectives.

The data for 1-hour worst case maximum with the new predicted that ambient concentrations of TRS at Robso µg/m³) and the hospital (4 µg/m³) would be within the A and Level B guidelines (7 µg/m³ and 28 µg/m³, respectiv The extreme maximum concentration generated by the m was substantially higher than the 1 hour Level A a guidelines but within the 24 hour Level B guidelines.

Sulphur dioxide levels posed the greatest concern. estimated SO_2 levels at Robson (144 µg/m³) and at the hos (153 µg/m³) for the 1-hour worst case extreme maxi were well within the Level A (450 µg/m³) and Level B (90 m³) guidelines. However, the maximum recorded value (µg/m³), presumably adjacent to the mill, was far above guidelines.

The estimated frequency of exceedances of the guide with the proposed mill showed major improvements in levels from 1,594 Level A and 449 Level B exceedances a hospital to no exceedances with the proposed mill. SO_2 1- worst case maximum exceedances of Level A or

B are not predicted to occur at Robson or the hospital recording stations (Figure 20), but they do occur at other locations. The modelling results predicted that SO_2 concentrations for the maximum 1-hour period would increase the area of Level A and Level B exceedances, in the vicinity of the pulp mill.

The Ministry of Environment indicated that, in their view, these predictions understated the potential emission rates. They especially questioned the interpretation of the "normal process" scenarios which did not include conditions involving the shutdown of the lime kiln and power boilers for regular monthly maintenance. Their analysis of TRS levels indicated:

- both Level A and B one hour levels will be exceeded, the maximum being 46 $\mu g/m^3$, occurring on low terrain just south of the mill;
- the maximum 24 hour level will be 4 $\mu g/m^3$, occurring near the west edge of the plant site;
- the area just west of the dam will experience between 50-480 one hour Level A exceedances while the area between the mill and the dam will experience at least 16 exceedances of the 24 hour Level A;
- on all accounts the TRS levels will be much lower than current levels.

Their analysis of SO_2 levels indicated:

- a worst case scenario with SO_2 levels greater than 6500 $\mu g/m^3$ on the south shore of the river and greater than 1800 $\mu g/m^3$ on the north shore;
- a zone on the hillside perhaps a kilometer long that would experience SO_2 levels greater than 3000 $\mu g/m^3$;
- a high number of exceedances of reference levels west of the mill while the highest concentrations would occur south of the mill, illustrating the influence of winds.

According to the Ministry of Environment, large areas on both shores could experience SO_2 levels in excess of the Level A and Level B guidelines. They attributed this largely to diverting TRS from the lime kiln to the power boiler during the maintenance shutdowns. However, the prediction of excess SO_2 levels is questionable. There is a possibility of incineration of TRS in the power boiler reducing the level of SO_2 emissions (see section 5.4.2). Furthermore, the actual emissions of SO_2 from the recovery boiler could be only 20 per cent of that used in modelling.[8]

The Ministry stated that their analysis " illustrates that the potential for very high SO_2 levels or very frequent moderate SO_2 levels during the lime kiln shutdowns makes the shutdowns environmentally significant events that warrant closer scrutiny".[9]

They also suggested that an alternative method of incinerating TRS be considered for lime kiln shutdowns (e.g. a special TRS incinerator with SO_2 scrubber).

In terms of normal operation, the federal Department of the Environment, the federal Department of Fisheries and Oceans and Dr. Murray noted that Celgar's estimates of SO_2 emissions from the lime kiln were too high.[10]

Relative to the recovery boiler, the Department of the Environment and the Department of Fisheries and Oceans brief gave an example of increased black liquor solids reducing SO_2 emissions.

The provincial Ministry of Environment also indicated some concern over the estimated worst case maximum NO_2 levels near the mill as a result of interactions of NO_x and SO_2.[11] Limited information was available on the probable effects of a combination of air contaminants.

Celgar responded to the various concerns over SO_2 emissions by questioning whether the worst case modelling was realistic and by a commitment to monitoring and appropriate response if problems arise. They stated:

> We will be monitoring the situation. We will be assessing it, particularly concerning sulphur dioxide, after start-up. And if there are problems, we will then do something about it. But I think that the model as has been described, as has been discussed this evening, models are predictors, or they attempt to be predictors, and they do not represent reality. Reality may show that there is not a problem with this, in which case we would proceed. If there was a problem we would then take the appropriate action to solve it.[12]

It is apparent that major differences existed between the company and government technical experts regarding the severity and the frequency of worst case air emissions. These differences arose directly from the uncertainties of modelling studies.

With some indications that estimated levels of SO_2 emissions from the recovery boiler, No. 2 power boiler and the lime kiln may be too high, and with uncertainty over the results of modelling studies, predictions of ambient SO_2 concentrations are tenuous. The Panel concludes that concentrations of SO_2 are likely to increase in the vicinity of the pulp mill. However, the severity and specific area of impact are uncertain. This is primarily due to the unreliability of modelling results, possible differences between actual performance and estimates of SO_2 emissions, and inadequate consideration of the effects of background levels of SO_2. Nevertheless, the Panel is satisfied that the emission rates from SO_2 sources are controllable and manageable. Feasible measures are available to reduce SO_2 concentrations exceeding Level B guidelines, should they occur. Effective arrangements are needed to ensure prompt response to adverse conditions and exceedances of air quality objectives.

Recommendation 39

The Panel recommends that regular maintenance shutdowns of the lime kiln be timed to avoid adverse weather conditions and so minimize ambient SO_2 concentrations (See also Recommendation 17).

8. Mr. P. Sagert, Technical Hearings transcripts, Vol. 10, p.2128; Mr. B. Briscoe, Technical Hearings transcripts, Vol. 8, p.2013.
9. Ministry of Environment, op. cit. p. 28.
10. Department of the Environment and the Department of Fisheries and Oceans, Technical Hearings Document No. 53, p. 20.
11. Dr. R. Bennett, Ministry of Environment, Technical Hearings Transcripts, Vol. 10, p. 2299.
12. Mr. L. Parnell, Celgar Pulp Company, Technical Hearings Transcripts, Vol. 10, p. 2406.

7.4 Health and Safety Concerns

Of the many issues associated with the proposed expansion of Celgar Pulp, few are more complex or important than maintaining air quality at levels that protect the health and safety of workers and the local community. The consideration of potential health impacts involves variables such as the type and concentration of the contaminant, the frequency and duration of exposure and the particular sensitivities of the individual.

No evaluation of health aspects of air emissions was requested or provided in the Stage II Report. Protecting the health and safety of workers - both those involved in the construction of the proposed new mill and permanent employees - is a primary concern due to the risks of accidental gassings and the potential effects of long-term exposure to low concentrations of toxic substances, including dioxins. From the perspective of workers, impairment of respiratory functions and occupationally-induced cancer remain the primary concern. Regarding the community at large, reductions in contaminant emissions will also reduce the significant public concern about the health effects of long term exposure to pulp mill pollution.

7.4.1 Workplace Air Quality

Risks of Respiratory Impairment

Even though most ambient air quality levels will improve in the mill and in the community at large, workers remain susceptible to accidental gassings and long-term, prolonged exposures to various emissions. These emissions may result in impairment of respiratory functions. The prolonged exposure of workers to potentially harmful emissions led one intervener to state:

> ...we [workers] are like the canary in the mine. We are presumably the first indicators of any health-related problems in Castlegar and district area due to gas-related incidents.[13]

Accidental gassing of construction workers and millworkers was the major concern noted by the company. Dr. Jeffries, a consultant to Celgar in the field of occupational health and safety, reviewed medical literature pertaining to the effects of exposure to sulphur dioxide, TRS gases (hydrogen sulphide, methyl mercaptan, dimethyl disulphide and dimethyl sulphide), particulates, nitrogen oxides, chlorine and chlorine dioxide. The effects of exposure to these gases create concerns about the risk of respiratory impairment. Concerning exposure to a heavy dose of chlorine gas, Dr. Jeffries stated:

> For the exposures in the occupational setting, the findings are less clear, with some reports indicating that heavily exposed workers had evidence of air flow obstruction two years after exposure.[14]

Dr. Jeffries referred to a medical survey of Woodfibre Pulp Mill workers which "noted that workers who reported gassings showed evidence of reduced lung function, and these workers also reported more cough and wheeze."[15]

Information presented by one participant suggested that pulp mill workers were two times more likely than other occupational groups to report respiratory problems.[16] respiratory health survey at another pulp mill indicated th pulp mill workers reported relatively more wheezing comparison with railyard workers, regardless of smoki habits, and a higher proportion of respiratory problems w workers who had been subjected to accidental gassi incidents.[17]

Accidental gassings are also a major concern of worke The PPWC suggests that leaks of gas, such as chlorine dioxi through accidental breakage of pipes during construction process upsets posed serious health risks.[18] The PPW discussed gassings that have occurred in other pulp mills illustrate the fact that gassings present an ongoing occupatio health hazard. The PPWC also provided accident statistics 1990, from January to October. These statistics indicated th 65 out of 288 first aid cases involved inhalation, ingestion absorption, most likely the result of gassings.[19]

The company indicated that the construction site pla were reviewed in relation to Workers' Compensation Bo standards adapted for use in similar pulp mill construct projects and suggested that the British Columbia and Yuk Building Trades Council are satisfied that these standards w protect workers health.[20] Mr. Jim Lipperts, representing t organization, expressed satisfaction with the compar cooperation in identifying a site for the construction ca and suggested that the company had shown sensitivity on issue of camp environment. Mr. Lipperts conveyed understanding that "worker health and safety will b priority, and new equipment will virtually eliminate chance of exposure to hazardous gasses and chemical spills

One important aspect of gassings involves technolog measures to limit the risk to workers. Concerning chlor dioxide, a consultant to the company, Dr. B. Willis, sta that as chlorine dioxide would be used in highly contro conditions:

> ...the chances of flashback of gases during the bleaching process would be much diminished compared to using chlorine, which is administered directly as a gaseous form into the bleach chain.[22]

Dr. Jeffries noted further that workers would also be supp with respirators as protection against chlorine diox gassing.[23]

13. Mr. C. Him, Pulp, Paper and Woodworkers Union Local No. 1, Tech Hearings Transcripts, Vol. 4, p. 896.
14. Dr. E. Jeffries, Technical Hearings Transcripts, Vol. 10. p. 2162.
15. ibid.
16. Dr. C. DeMarco, Technical Hearings Document No. 74, p. 9.
17. Kennedy, S. et al., Woodfibre Pulp Mill Respiratory Health Su Community Hearings Document No. 4.
18. Mr. C. Him, Technical Hearings Transcripts, Vol. 10, p. 2206.
19. Mr. B. Reiter, Pulp, Paper and Woodworkers Union Local No. 1, Tech Hearings Transcripts, Vol. 4, p. 903.
20. Celgar Pulp Company, Closing Statement, November 9, 1990, p.
21. Mr. J. Lipperts, British Columbia and Yukon Building Trades Cou Community Hearings Transcripts, Vol. 7, p. 99-100.
22. Dr. B. Willis, Technical Hearings Transcripts, Vol. 4, p. 1148.
23. Dr. E. Jeffries, Technical Hearings Transcripts, Vol. 10, p. 2452.

Comprehensive workplace monitoring programs were advocated by the PPWC, which recommended that mobile monitors be established.[24] The PPWC recommended that the company provide in-plant monitoring of chlorine dioxide, non-condensible gases and methyl mercaptans. The Ministry of Health also indicated that plant monitoring systems were needed to warn workers of toxic spills and gas releases.[25]

Concerning the possible health risks due to occupational exposure to emissions, the PPWC requested that a respiratory health study be conducted in conjunction with Celgar, the UBC Occupational Lung Disease Research Unit and the Workers' Compensation Board.[26]

Cancer Risk From Exposure to Dioxins and Furans

Exposure of workers to dioxins and furans formed in the proposed pulp mill process present a further set of health related concerns. Medical research examining the links between dioxin and furan exposure and cancer indicates great uncertainty as to the long term health consequences.

Dr. Jeffries reviewed various epidemiological studies. He concluded that studies have not demonstrated a higher risk of occupationally-induced cancers among pulp mill workers. He suggested that the effects of personal lifestyle in contributing to cancer was noted as one factor "confounding" some studies, such as the Prince George health profile. In his opinion, the difference between actual versus expected incidence of cancer in pulp mill workers identified by the Cancer Control Agency study of British Columbia was not statistically significant. A further limitation of the Cancer Control Agency study was the incomplete occupational information provided on the death certificates of pulp mill workers comprising the survey population. Quoting from a review of epidemiological studies of exposures to phenoxy herbicides and 2378 TCDD, Dr. Jeffries stated:

> There is a lack of consistent findings in the epidemiological studies, particularly for cancer. No study appears more credible than any other, and none can be sanctioned.[27]

Dr. Jeffries concluded that:

> ...there is no consistent evidence of site-specific cancer risks among pulp mill workers and no evidence of community cancer risks from pulp mills.[28]

Dr. Willis noted that investigations of the original BASF study frequently came to different conclusions about the relationship between cancer and exposure to dioxins.[29] One investigation reported a significant increase in respiratory and gastrointestinal tract cancers in workers but another concluded that no causal relationship between cancer and exposure to dioxins could be established. A further investigation concluded that a small hazard may exist for workers in environments which have elevated levels of 2378 TCDD and other chemicals.

Dr. Willis reported that studies do suggest that exposure to 2378 TCDD is linked to an increased incidence of chloracne, and possible adverse effects on pregnant women, but maintained that:

> ...currently available epidemiological data are inconclusive with respect to the demonstration of a causal relationship between cancer and exposure to 2,3,7,8-tetrachlorodibenzodioxin.[30]

At the same time, Dr. Willis acknowledged that there was uncertainty about the long-term impacts of exposure to dioxin. Referring to a 1976 study of children in Seveso, Italy, exposed to high levels of dioxin, he stated that the time period of 14 years is not adequate to conclusively evaluate the potential chronic effects such as cancer, particularly in young individuals.[31]

The Panel heard from several intervenors, including the PPWC who alluded to many of the studies referred to earlier by Dr. Jeffries and Dr. Willis. It was the opinion of the PPWC that these studies were cause for real concern about occupationally-induced cancers.[32] In the opinion of the PPWC it is impossible to make an informed judgement on the issue of dioxin exposure due to a lack of information. A submission by the Ministry of Health also referred to these concerns:

> Although the short-term health effects of dioxins and furans have been found to be less severe in the human population compared to those seen in research animals, there is still a serious concern for the long term health consequences.[33]

Health and Welfare Canada expresses similar uncertainties about exposure to dioxins. This agency states that:

> ...no conclusive link has been established between human exposure to dioxins and furans and cancers.[34]

However, the policy of both Health and Welfare Canada and the Ministry of Health is to minimize human exposure to dioxins and furans.[35, 36] The PPWC also believes that the proposed new mill should move towards the use of technology that eliminates the exposure of workers to potential carcinogens.

The elimination of potentially harmful substances in the workplace is the most effective means of protecting workers'

---

24. Mr. C. Him, Pulp and Paper and Woodworkers Local No. 1, op. cit., p. 2220.
25. Mr. J. Philion, Ministry of Health, Consolidated Provincial Government Agency Comments on the Stage II Report, September 27, 1990.
26. Mr. C. Him, Pulp and Paper Woodworkers Local No. 1, Technical Hearings Transcripts, Vol. 4, p. 896.
27. Dr. E. Jeffries, Technical Hearings Transcripts, Vol. 4, p. 1139, quoting Lillienfeld and Gallo, "Epidemiological Reviews," November, 1989.
28. Dr. E. Jeffries, op. cit., p. 1140.
29. These include the study of workers in Nitro, West Virginia, exposed to dioxins and other chemicals following an explosion in a Monsanto Corporation plant and a study of a similar incident occurring in a BASF plant in West Germany in 1953.
30. Dr. R. Willis, op. cit., p. 1145.
31. Dr. R. Willis, op. cit., p. 1147.
32. Mr. C. Him, Pulp and Paper Woodworkers Local No. 1, op cit., pp. 916-17.
33. Dr. N. Ames, Ministry of Health, Technical Hearings Document No. 64, p. 1.
34. Health and Welfare Canada, Issues - Dioxins and Furans, September, 1990, p. 3.
35. Letter to CERP from Health and Welfare Canada, October 23, 1990.
36. Dr. N. Ames, Ministry of Health, op. cit., p. 3.

health. However, reducing the uncertainty about the long term impacts of occupational exposure to dioxins and other substances in pulp mills is seen as a necessary interim measure. Several respondents recommended that Celgar participate in an epidemiological study of cancers affecting pulp mill workers, currently being planned by the Cancer Control Agency of British Columbia.[37]

The above submissions to the Panel emphasized the need for the proposed facilities to be designed so as to minimize human exposure to hazardous chemicals.

The old age of much of the equipment in the existing mill increases significantly the possibility of failures (e.g. of pipes, pumps, fans) which can lead to increased number of exposures. From this point of view, the introduction of the new process equipment will represent a major improvement. The advanced computer control system planned for the modernization should also increase operator knowledge of what is happening in the process as well as improving process control. Together these will result in fewer process upsets and an improvement in worker environment. The drum washers in the existing mill fibre line result in some exposure of workers to gases, aerosols and liquids. Bleach plant aerosols can contain dioxins and furans. The use of diffuser washing technology will significantly reduce exposure to bleaching and cooking chemicals, in both liquid and gaseous forms.[38] In addition there will be modern evacuation systems to collect gases for incineration or scrubbing.

With respect to exposure of workers to organochlorines, especially dioxins and furans, the technology to be adopted to reduce AOX in the effluent will also have beneficial effects with respect to environmental health.

The Panel believes that a modernization of the mill would be an ideal time to cement management/employee knowledge in the field of environmental health and safety protection and to ensure that adequate detection and mitigation equipment and procedures are in place.

Recommendation 40

The Panel recommends that Celgar be required to demonstrate measures to minimize the risk of exposure of residents of the construction camp to hazardous gases and chemicals.

Recommendation 41

The Panel recommends that the British Columbia Ministry of Health, Workers' Compensation Board and Cancer Control Agency studies of health risks to pulp mill workers in British Columbia include Celgar as a survey site, and make recommendations for control of workplace exposure to hazardous substances, and risk of respiratory disease.

Recommendation 42

The Panel recommends that Celgar involve the Pulp, Paper and Woodworkers Union, Local No. 1 in the design and implementation of measures to improve air quality in the workplace, and of measures to alert workers to the vigilance necessary to avoid or react to accidental discharges and emissions.

7.4.2 Community Air Quality

As noted above, Celgar states that emissions from the proposed new mill, with the exception of SO_2 and volatile organic compounds (VOCs), will be substantially below those from the current mill and that the effect will be a net improvement in community air quality in the Castlegar area. The decrease in TRS emissions will also significantly reduce odour from the pulp mill.

Dr. Jeffries reviewed the medical literature concerning the impacts of pulp mill emissions on the general public. The main points of Dr. Jeffries' summary are presented below:

Sulphur dioxide - Effects have not been observed among healthy subjects exposed for brief periods to concentrations of less than 1 ppm; exposures of individual exercising asthmatics to levels under 0.75 ppm did not cause consistent change. A study of acidic mixtures of sulphur dioxide which was 0.1 ppm sulphuric acid and nitric acid noted some significant lung function changes in asthmatics and in exercise induced bronchi spasm. Some asthmatics can experience symptoms and airways resistance at concentrations as low as 0.4 ppm; the health effects are enhanced by combined exposure to water vapour, sulphuric acid aerosols and inert dusts. Consistent effects on asthmatics have been noted at 0.75 ppm. The desirable standard for sulphur dioxide in British Columbia is 0.17 ppm.[39]

TRS gases - TRS gases include hydrogen sulphide, methyl mercaptan, dimethyl disulphide and dimethyl sulphide; of these four gases medical information is available for only hydrogen sulphide. Exposure levels of 50 to 60 ppm for 30 to 60 hours produces conjunctivitis and sinusitis in individuals. Review of sour gas emissions in Alberta, pulp mills in New Hampshire and community residents in Maine do not show a statistically significant effect on human health. A review of TRS emissions in Prince George showed an apparent relationship with hospital emergency visits.[40]

Particulates - Particles between 0.5 and 10 microns can penetrate the lower airways and alveoli of the lungs and not be cleared by protective mechanisms of the lungs. The study of emergency ward admissions in Prince George found an apparent relationship with measures of total suspended particulates. Fine particulate (PM10) may be more significant than actual concentration but some medical practitioners

37. Mr. C. Him, Pulp and Paper Woodworkers Local No. 1, op. cit., Vol. 4, p. 899.
38. Mr. B. Prough, Technical Hearings Transcripts, Vol. 8, p. 1999.
39. Dr. E. Jeffries, Technical Hearings Transcripts, Vol. 10, p. 2157.
40. Dr. E. Jeffries, op. cit., p. 2158-60.

state that health data can not technically support U.S. standards for PM10.[41]

Nitrogen Oxides - The U.S. EPA observes mild symptomatic effects in asthmatics exposed at levels of 0.5 ppm for two hours and more serious impairment has been demonstrated in chronic bronchitics at exposures of 1.6 ppm for 3 minutes. The U.S. EPA did not find quantifiable evidence of health effects. Children living in homes with gas stoves had a slightly higher incidence of respiratory disease, but other factors such as humidity, formaldehyde and carbon monoxide may have been contributing factors.[42]

Chlorine and Chlorine Dioxide - Medical literature indicates that a single, heavy dose does not appear to result in chronic respiratory health abnormalities in a community setting.[43]

With the current mill in operation, concentrations of particulates measured at Robson and the hospital were 0.001 ppm compared to the provincial Ministry of Environment's desirable levels of 0.03 ppm. Similarly, concentrations of TRS at the same locations were 0.002 ppm compared to desirable levels of 0.05 – 0.02 ppm. Concerning SO_2, the worst reading recorded at Robson and the hospital was 0.08 ppm, or 50% below the desirable level of 0.17 ppm.

Concluding his assessment of health impacts of pulp mill emissions on the community, Dr. Jeffries stated that predicted concentrations of TRS, particulates and sulphur dioxide would be at levels consistent with protecting public health:

> The EPA, National Institute for Occupational Safety and Health, the Workers' Compensation Board, and other governmental standards-setting bodies build in factors of 100 to 1,000 fold to protect public health. The figures that I have seen for each of these components in the local community in Castlegar provide a further two to ten-fold protection. I am confident that these levels from the proposed mill will not produce adverse human health effects.[44]

According to the Ministry of Health, much of its concern regarding emissions from the proposed new mill involves impacts on individuals hyper-responsive (asthmatic) to the inhalation of sulphur dioxide and other sulphur compounds. The Ministry of Health reported that approximately 10% of the general population are asthmatic and that the projected increase in sulphur dioxide emissions may result in health consequences to these persons.[45]

Concerning the effects of emissions from the present mill, one local physician practicing in the Castlegar area stated that the incidence of respiratory illness in Castlegar was no greater than found in large cities and may even be less.[46] By contrast, another local physician suggested that emissions from pulp mills had been linked to various respiratory problems.[47]

Differences of opinion among members of the local medical community and area residents reflect the lack of epidemiological studies on the effect of pulp mill emissions on community health. While levels for most contaminants and total emission loadings will decline, there is uncertainty about the long term medical effects, particularly on those members of the public who have respiratory sensitivities. Governments should continue to monitor research results in this field for indications of a need for regulatory action.

Many interveners commenting on potential community health risks from mill emissions suggest that Celgar be required to establish a comprehensive ambient monitoring program. In this regard, the company states that its ambient air quality program will include a sulphur dioxide analyzer in Castlegar and a TRS analyzer at the Keenleyside dam (see also Section 7.8).

The Panel is satisfied that relative to aesthetic effects, odour and visible air pollution from the mill will be substantially reduced.

7.5 Acid Deposition Potential

The increased emissions of SO_2, combined with NO_x, are a concern because they could result in increased acidic deposition which could affect aquatic and terrestrial ecosystems. Nitrates and sulphates are removed from the atmosphere and deposited primarily by dryfall, rain and snow.

Celgar prepared an analysis in the Stage II Report and the Additional Information Report on acid deposition potential. They estimated wet sulphate deposition at a maximum value of 768 mg/m²/yr at 4 km from the mill and wet nitrate deposition at a maximum value of 12 mg/m²/yr at 4 km from the mill.[48] The model was later rerun using actual values and consideration of seasonal variations in deposition. Estimated deposition of sulphate was 38 mg/m²/yr and 5 mg/m²/yr.[49] Total (wet and dry) deposition was estimated at 711 mg/m²/yr of sulphate and 15 mg/m²/yr of nitrate at 2 km distance from the mill, and 16 mg/m²/yr of sulphate and 10 mg/m²/yr of nitrate at the U.S. border.[50] The company stated that the deposition rates were estimated to be forty times lower than the rates necessary to create acidification of lakes, although no information was provided on the actual buffering capacity of lakes in the region which would be a major determining factor.

The federal Department of the Environment expressed concerns about acid deposition, primarily because of the lack of observational or field data on current levels of acidic deposition in the Castlegar and Columbia River areas.[51] They also indicated uncertainties exist regarding potential transboundary transport of sulphur oxides. A monitoring program was therefore recommended by the federal government to obtain actual deposition measurements.

Provincial officials noted that an acid deposition monitoring station at Cranbrook was recently closed since the data

41. Dr. E. Jeffries, op. cit., p. 2160.
42. Dr. E. Jeffries, op. cit., p. 2161.
43. Ibid.
44. Dr. E. Jeffries, op. cit., p. 2164.
45. Ministry of Health, Technical Hearings Document No. 64, p. 1.
46. Dr. R. Ward, Community Hearings Transcripts, Vol. 1, p. 124-125.
47. Dr. C. DeMarco, Technical Hearings Transcripts, Vol. 9, p. 1726-30.
48. Celgar Pulp Company, Stage II Report, Vol. 4, "Air Emissions and Air Quality Impact Assessment," p. 181.
49. Celgar Pulp Company, Additional Information, p. 30.
50. Dr. M. Ruby, Technical Hearings Document No. 89.1.
51. Department of the Environment and the Department of Fisheries and Oceans, op. cit., p. 22.

indicated no problems. They suggested that a similar station was needed in the Castlegar area.

The corrosion effects attributable to the existing and proposed mills were discussed. One intervener, Mr. Lowe, presented evidence indicating a higher than average corrosion rate on aircraft parts. He attributed this to the impacts of sulphur dioxide emissions from the Celgar mill.[52] He argued that the plume from the existing mill frequently drifted over the Castlegar airport creating excessive rates of corrosion. Another representation regarding aircraft corrosion indicated that while some corrosion was evident, it did not pose a particular concern.[53] A study prepared by the Ministry of Environment comparing corrosion rates at a pulp mill and a smelter near Castlegar was submitted to the Panel.[54] The study indicated a direct relationship between corrosion of aluminum and sulphation. However, no evidence was presented showing that corrosion rates were excessive.

Dr. Ruby, a consultant to the company, reviewed the proposed sulphur dioxide emissions from the new mill in terms of incremental increases to wet and dry deposition. He stated three variables were associated with corrosion: surface wetness, wind speed and pH of the surface water. He estimated that about a 2% increase in corrosion in the Castlegar area might be expected due to an increase in total sulphur loading from the proposed mill.[55] He also suggested that most corrosion in the area was due to the natural pH of rain.

Ministry of Environment staff suggested a need for further corrosion studies, before, during and after construction, in order to determine whether unusual corrosion rates are occurring.

The Panel concludes that SO_2 emissions, should they occur as predicted, will likely contribute to higher levels of acid deposition and slightly higher corrosion rates. However, the specific rates of deposition and corrosion are unknown as are their effects. The Panel recognizes that SO_2 emissions could pose a problem and recommendations are provided which therefore focus on source control, monitoring and response to impacts. There is sufficient uncertainty regarding SO_2 concentration and deposition to justify monitoring of acid deposition in the area.

Recommendation 43

The Panel recommends that the British Columbia Ministry of Environment establish an acid deposition monitoring station in the vicinity of Castlegar.

7.6 Vegetation and Ecosystem Impacts

Celgar presented an evaluation of the potential effects on vegetation from predicted air quality in the vicinity of the pulp mill. Vegetation injury thresholds were determined from the literature and dose response relationships were estimated. According to the analysis, under normal process conditions, SO_2 injury to vegetation may occur in the immediate vicinity of the proposed mill, and is most likely to occur during worst case conditions.[56] No injury to vegetation should occur either at Robson or at Castlegar hospital. With respect to NO_x and TRS, no injury to vegetation is predicted.

Relatively little is known about the sensitivity of most tree and vegetation to acid deposition. Celgar concluded nevertheless, that due to low acid deposition rates and th ability of terrestrial ecosystems to buffer the acidity precipitation, no negative acidification effects on soils an vegetation are anticipated.[57] Little information was provide on the potential impacts on aquatic systems. The bufferin capacity of lakes and streams was not specifically considere by Celgar since the rate of acid deposition is relatively lo This view of acidification effects contrasted sharply with th of the Ministry of Environment staff.

The Ministry of Environment argued that SO_2 emissions w result in significant risk to vegetation of the area. The concluded that SO_2 long-term mean values may p vegetation at risk immediately west of the mill over a distan of approximately 2 km (Figure 19).[58] The maximum 1-ho normal process values and the worst case values are predicte to result in vegetation impacts. Particular concerns we expressed that peak levels may approach critical doses According to the Ministry, vegetation within a distance approximately 2.5 - 3 km will likely experience injury. Oth adverse effects on vegetation could occur up the hillsides an down the valley.

Some of the government concerns were associated with t synergistic effects of pollutants. Celgar's consultant point out the variability of effects and the lack of reliable dos response relationships from combinations of pollutan Ministry staff and others recognized the curre methodological limitations of vegetation impact assessme and the degree of professional judgment which is require

Many uncertainties were evident in the assessments vegetation impacts. This was especially attributable to t lack of site specific data regarding vegetation sensitivity a dose-response relationships, as well as the hypothetical natu of the analyses. Accordingly, the Panel concludes that t vegetation impact prediction studies were inconclusive a that selective monitoring of actual effects is needed.

Recommendation 44

The Panel recommends that the federal and Briti Columbia governments apply air emission standards whi will protect vegetation, and aquatic and terrestr ecosystems from significant injury, and that Celgar required to measure environmental effects of the mill on quality and vegetation.

52. Mr. R. Lowe, Technical Hearings Transcripts, Vol. 10, p. 2223-2253
53. Mr. D. Nielson, Adastra Aviation, Community Hearings Transcri Vol.1, p. 269-70.
54. Kotturi, M. S., "The Corrosion Rates of Metals Exposed to Pulp-Mill Smelter Emissions", January, 1980, Community Hearings Docum No. 8.
55. Dr. M. Ruby, Technical Hearings Transcripts, Vol. 10, p. 2192.
56. Dr. S. Linzon, Technical Hearings Document No. 91, "Potential Eff on Vegetation".
57. Celgar Pulp Co., Additional Information, p. 32.
58. Mr. J. Van Barneveld, Ministry of Environment, Technical Hear Document No. 55 (Addendum).
59. Mr. J. Van Barneveld, Ministry of Environment, Technical Hear Transcripts, Vol. 10, p. 2303.

7.7 Greenhouse Gases

Concerns were expressed about emissions from the proposed new mill consisting of carbon dioxide (CO_2), methane, cloroflorocarbons (CFCs), oxides of nitrogen, and ozone (collectively known as "greenhouse gases"). Greenhouse gases are thought to be contributing to climate change, with uncertain global environmental effects. Throughout the Community Hearings, many respondents stated that the company had not addressed greenhouse gases in its Stage II Report, despite the unprecedented level of federal and provincial concerns.[60] They noted that the pulp and paper industry is a particularly high contributor to CO_2 emissions within the province. While most concern related to direct emission of greenhouse gases from the new mill itself, other concerns related to greenhouse gas emissions resulting from the increase in chip truck traffic.

The Ministry of Environment acknowledged that greenhouse gases were not incorporated into permits and that Celgar had not been asked to quantify the change in greenhouse gas emissions associated with the expansion.[61] The federal Department of the Environment discussed the general importance of greenhouse gases in the context of the global environment, suggested that greenhouse gases might be regulated in the near future and drew the Panel's attention to the federal government's interim target to hold CO_2 levels to 1990 levels by the year 2000.[62] Both the federal Department of the Environment and Department of Fisheries and Oceans recommended that the company provide information about CO_2 emissions, attempt to minimize the use of fossil fuels and practice energy efficiency.[63] The Ministry of Environment advised that future regulatory controls over CO_2 emissions would apply to the proposed new mill.[64]

Celgar acknowledged the increases in greenhouse gases. It indicated that increased energy efficiency would cause CO_2 emissions from the proposed mill to fall by 50% on a per tonne of pulp basis compared to current levels. However, increased pulp production was estimated to result in total CO_2 emissions increasing by 16%[65], although this was later estimated at 68%.[66] In a written submission following the hearings, the company provided revised estimates of CO_2 production:

> The CO_2 emission rates are projected at 4.39 and 3.17 t/ADt [tonnes per air-dried tonne] from the existing and modernized mill respectively. For the respective production rates, this converts to 793,500 tonnes/year of CO_2 from the existing mill and 1,330,900 tonnes/year CO_2 for the modernized mill.[67]

The proposed truck transport of wood chips would add 21,400 tonnes/year based on Celgar's preferred wood chip transportation option to the 18,400 tonnes/year from current operations.[68]

Celgar also stated that CO_2 emissions from non-renewable, fossil fuels would be reduced by 700 tonnes per year, due to energy self-sufficiency in the new mill. They suggested that the new mill would rank high in terms of energy efficiency as compared to other kraft pulp mills.[69] Another aspect of the proposed new mill's impact on greenhouse gas emissions was the effect of utilizing fibre that would otherwise be burned as slash or left to decay, thereby contributing to the production of greenhouse gases.

In regard to greenhouse gases, Celgar stated that it is difficult to give reliable predictions at the smaller scales demanded for an environmental impact assessment, adding that:

> There is no protocol on how to develop a scenario and how to determine the emissions with respect to global warming that has been published by the government and defined with some degree of rigor.[70]

Based on data provided by the company related to energy use, Celgar has taken steps to conserve energy. By that criterion, the company appears to have followed the principle of energy conservation recommended by the federal government, as noted above. As well, there is the possibility of achieving further reductions in energy leading to lower emissions of greenhouse gases.

Recommendation 45

The Panel recommends that the federal and provincial governments establish impact assessment and control guidelines in conjunction with their international endeavours regarding greenhouse gases, and that Celgar be required to comply, should emissions from the mill be found to exceed the guidelines.

7.8 Air Quality Monitoring

The existing ambient air quality monitoring program currently includes stations at Robson, Castlegar hospital and the library (Figure 20). The monitors were purchased by Celgar and operational costs are shared with Ministry of Environment. Celgar stated that the program will be expanded and guided by the following objectives:

(1) To determine the TRS, odour, particulate, fine or respirable particulate, and sulphur dioxide concentrations in the Castlegar area of the Columbia River Valley.

60. Mr. D. Lewis, Community Hearings Transcripts, Vol. 2, p. 100.
61. Ministry of Environment, Technical Hearings Document No. 55 (Addenda), p. 12-13.
62. Mr. F. Mah, Department of the Environment, Technical Hearings Transcripts, Vol. 10, p. 2260-61.
63. Mr. M. Nassichuk, Department of Fisheries and Oceans, Technical Hearings Transcripts, Vol. 4, p. 982.
64. Ministry of Environment, op. cit.
65. Mr. B. Briscoe, Community Hearings Transcripts, Vol. 3, p. 259.
66. Mr. P. Sagert, Cirrus Consultants, Response to Questions Raised During Hearings, Nov. 9, 1990, p. 2.
67. Ibid.
68. Ibid.
69. Mr. P. Sagert, Technical Hearings Transcripts, Vol. 10, p. 2170.
70. Mr. P. Sagert, Technical Hearings Transcripts, Vol. 10, p. 2172.

(2) To determine whether the measured ambient air quality concentrations comply with the Canadian and British Columbian ambient air quality guidelines.

(3) To provide assurance to the Ministry of Environment and the public that the environment is being protected through the reporting of this information to both government and the public.

(4) To allow for appropriate control action under extremely adverse meteorological conditions which could adversely affect the ambient air quality in the Castlegar area.

(5) To facilitate responses to questions concerning the effect of pulp mill emissions on regional air quality.

(6) To specifically respond to and to resolve air emission problems, should they arise.[71]

The expanded program will include a new SO_2 analyzer in the Castlegar area and a TRS analyzer above the Keenleyside dam. Celgar indicated that they would have the capability to respond to air pollution episodes from severe meteorological conditions which could have an adverse effect on ambient air quality.

Celgar also stated that a special purpose monitor program would be established for:

(a) assessing vegetation impacts at the point of maximum concentration of SO_2 on the hillside adjacent to the mill; and

(b) spot sampling of air at various locations to determine emissions sources.

The Ministry of Environment stated that the details of an ambient monitoring program are normally finalized as part of the permitting process and indicated that a significant expansion of the monitoring program would be required if the mill were approved. The ambient monitoring program envisioned by the Ministry of Environment would expand the number of stations, increase the range of parameters monitored on a continuous basis, and review the locations of monitoring stations in conjunction with the Ministry of Health.[72] They recommended that an ambient monitoring program consist of measurements of at least three residential areas, with the target contaminants determined by the Medical Health Officer.[73] They also suggested:

- all continuous ambient monitors be electronically linked to the plant control room and the Ministry offices;
- ecosystem (vegetation and soils) monitoring in sensitive receptor locations;
- acid deposition and corrosion studies at sensitive sites.

Representations by the union suggested a minimum of four TRS monitors at the mill site and use of mobile monitoring equipment particularly at the construction camp. The mobile monitors offer an ability to determine unusual sources, to respond to complaints and the provide a backup unit. They also expressed concern about emissions from the effluent treatment pond and the need for greater monitoring on-site for worker protection.

The PPWC also recommended that community monitoring stations be established at Selkirk College, the Castlegar Airport, between the Keenleyside dam and Syringa Creek and at Valley Vista Elementary School.

Recommendation 46

The Panel recommends that Celgar be required to include in its air monitoring program a mobile unit, and also two additional continuous monitoring stations linked electronically to the plant control room and local offices of the Ministry of Environment.

7.9 Enforcement and Compliance

The current mill has had a continual problem in complying with provincial permits for air emissions. The Ministry of Environment stated that a much more rigorous set of enforcement rules will be applied to the proposed new mill. They indicated that they will require constant monitoring and will undertake occasional audits of mill operations.

Representatives from PPWC emphasized the need for plant controls which prevent minor and major process upsets. As noted earlier, numerous public submissions expressed a lack of confidence in past performance of compliance and enforcement of air emission standards.

The Panel concludes that thorough monitoring and inspection by the Ministry of Environment is critical to ensuring that air quality objectives for the proposed mill are met.

71. Mr. B. Briscoe, Technical Hearings Transcripts, Vol.10, p. 2194.
72. Ministry of Environment, Technical Hearings Transcripts, Vol. 10, 2305-6
73. Mr. J. Philion, Ministry of Health, op. cit.

Chapter 8: Economic, Social and Community Issues

8.1 Community Development and Stability

8.1.1 Current Impact of Celgar

Throughout the hearings, the Panel was given a substantial amount of information which attested to the economic and social importance of the Celgar pulp mill to the West Kootenay region and the City of Castlegar since 1960.

In 1989, the mill employed a total of 380 persons, 90% of whom lived in Castlegar or the immediate area, and had a total payroll of $24.5 million.[1] Local citizens spoke of the importance of the mill to the community:

> Without the 400 Celgar workers Castlegar's economy cannot prosper. And this is my final reason for supporting Celgar, and it may seem selfish. But I like Castlegar, I like the city, and the people, and the way of life. The thought of losing this makes me sad and frightened.[2]

For three decades the Celgar mill has played an important role in the economic viability of the regional forestry industry. The critical importance of Celgar to local sawmills was emphasized by one local sawmill owner, who said:

> We in this particular area here at Slocan are directly tied to this pulp mill here at Castlegar, whether it is this size of the pulp mill or an expanded size is somewhat immaterial. We are directly tied there, as I say, for the main, fundamental reason that we just got to have the dollars from pulp mill chips to survive, it's locked into the economy.[3]

Similar opinions were expressed by other intervenors representing regional sawmill industries[4,5,6] as well as by the International Woodworkers of America.[7]

The City of Castlegar and other communities emphasized the critical role of Celgar in their economic and social security. For example, the mill contributed $721,858 in property taxes to the City of Castlegar, accounting for nearly 28% of the City's total property tax revenues.[8] Celgar's 1989 tax payments of $193,690 accounted for nearly 11% of the Central Kootenay Regional District's tax revenues. Celgar also contributed $35,350 to the region-wide hospital levy, about 4% of the total.

8.1.2 Impact of the Expanded Mill

The proposed new mill would add 30 new direct jobs initially and an additional 10 to 15 jobs once the woodroom is reactivated.[9] Celgar estimated that total employment at the new mill (420 to 425 permanent jobs) would result in approximately 3,000 person-years employment throughout the provincial economy. Much of this additional employment is expected to be in sawmilling and trucking industries in southeastern British Columbia. The sawmilling and trucking sectors are projected to experience an increase in employment of 1,000 and 570 person-years respectively.

Research conducted by consultants for the Castlegar Chamber of Commerce suggested an expanded mill would have an impact on local employment and immigration. Based on an increment of 55 new jobs (slightly greater than the company's estimate of 40 - 45 new jobs), they estimated that half of the new positions would be filled from individuals not currently residing in the region. This in-migration would result in a projected population increase of 63 persons, 90% of whom are expected to reside in Castlegar. They predicted that expansion would generate an additional 50 jobs through indirect and induced effects.

Most discussion of the social and community impacts of the proposed expansion related to the substantial economic benefits which would accrue to the Castlegar area and to the provincial economy. Submissions equated these benefits to long term economic stability of the Castlegar area and, in turn, to the general health of the community. According to Celgar, the most apparent social cost of the proposed new mill during operations would be the increase in chip truck traffic.

At a local and regional level, the company suggests that the proposed expansion would be particularly beneficial to the regional sawmill industry and regional trucking industry, both as a result of increased chip purchases. The main consequence of increased purchases in the sawmill and trucking sectors is to further stabilize the economy, particularly for smaller communities which are highly dependent on the viability of local sawmills.

The City of Castlegar provided a detailed assessment of the impacts of the proposed expansion on local and regional property tax revenue.[10] With the expansion, the City of

1. Castlegar Chamber of Commerce, Community Hearings Document No. 7, p. 2-3.
2. Mr. P. Johnstone, Community Hearings Transcripts, Vol. 1, p. 173.
3. Mr. I. Barber, Slocan Forest Products, Community Hearings Transcripts, Vol. 1, p. 280-81.
4. Mr. P. Kalesnikoff, Kalesnikoff Lumber, Community Hearings Transcripts, Vol. 1, p. 297.
5. Mr. W. Schmirler, Evans Forest Products, Community Hearings Transcripts, Vol. 6, p. 116-7.
6. Mr. D. Madlung, Westar Timber, Community Hearings Transcripts, Vol. 6, p. 122-3.
7. Mr. K. Offermann, IWA Canada Local 1405, Community Hearings Transcripts, Vol. 2, p. 41.
8. City of Castlegar, Technical Hearings Document No. 44, p. 12.
9. Mr. D. Hildebrand, Columbia Pacific Consulting, Technical Hearings Transcripts, Vol. 3, p. 632.
10. City of Castlegar, Technical Hearings Document No. 44.

Castlegar would realize an additional $2.6 million in property tax. Increased taxes would also accrue to the Regional District ($892,000) and the Regional Hospital District ($162,000). According to the City of Castlegar, such increases in tax revenue would allow for much higher levels of local services or provide for a substantial decline in property tax assessments for residential and other non-industrial properties. The additional hospital tax would be adequate to finance an additional $3 million in capital improvements. They indicated that the proposed new mill would also contribute an additional $1.34 million to provincial school taxes and a further $63,000 to other provincial authorities.

Investigations commissioned by the Castlegar Chamber of Commerce focused on the local, regional and provincial impacts of the proposed mill expansion, and compared these to the consequences of mill closure. With an expanded mill, the study projects that the main direct economic effects will be as follows for the Castlegar area: an additional $3.3 million in wages for the 90% of the new employees who will live in Castlegar; an additional $3 million in local chip purchases and $300,000 in procurement of other local goods and materials.

From a provincial perspective, the overall procurement expenditures of the new mill would increase from $83 million to $154 million. Of particular importance to the region is the fact that approximately $32 million will consist of chip purchases from local sawmills, including those located in the immediate Castlegar area.

8.1.3 Possible Mill Closure

As a contrast to the expansion scenario, the City of Castlegar offered its views on the possible impacts of a mill closure. If this were to occur, the City would lose $721,858 in tax revenue while the Regional District would lose $193,690. In the short term, this revenue loss would require substantial cuts in local services, an increase in property tax assessments or a combination of both. In the longer term, the City of Castlegar anticipated that a general erosion of the property tax base would occur due to declining property values and an out-migration of population. This in turn would result in even further declines in tax revenue coupled with the costs of maintaining an oversized infrastructure.

The study for the Chamber of Commerce projected that mill closure would have severe economic consequences to Castlegar and the surrounding region. In Castlegar, it was projected that closure would result in a total loss of 540 jobs and a total population out-migration of nearly 750 persons, including 265 children. Provincially, closure of the mill would result in a net loss of 1,560 person-years of employment, $73.3 million in wages and $132.1 million in income. Particularly affected would be the direct suppliers to the mill, who would experience a loss of 820 person-years of employment. Much of this employment is associated with local sawmills and logging operations.

Purchases of chips from eight regional sawmills totalled $33.7 million, with $11.5 million from two Castlegar area sawmills in 1989; these eight sawmills employed 2,000 persons, had a payroll of $104 million, and made $29 million in local purchases, not including logs.[11] The sawmills employ a further 1,100 persons in the logging sector.[12] In addition to purchasing chips, in 1989 Celgar spent $3.5 million in transporting chips to its mill, an expenditure which resulted in 40 person years of employment.[13] Celgar also purchased $9.5 million in local goods and services, of which $3.9 million was spent in Castlegar.[14] The value of these local purchases would be lost if the mill were closed.

8.1.4 Impact of the Proposal on West Kootenay Communities

The impressive range of participation at the community hearings was an indication of the importance attached to the Celgar expansion proposal and the conflicting values behind various communities' reaction to the impact of the proposal. Castlegar residents and those involved economically with Celgar's operation desired the expansion and its contribution to the commercial vigor and livelihood of this resource industry based region. Participants from as far away as Revelstoke and the Okanagan particularly appreciated the opportunity to sell the sawmill byproducts currently being disposed of or shipped elsewhere for processing. They also appreciated the environmental cleanup which would add to the attraction of the area for residents and visitors alike.

Residents of Trail, who have long coexisted with Cominco's operations, shared Castlegar residents' values regarding the livelihood which results from resource industries. They also shared their satisfaction resulting from improved environmental conditions as Cominco has modernized. All downstream communities told the Panel of their desire for the benefits to the Columbia River valley of Celgar's cleanup. There was some concern expressed about the continued impact of effluent discharges from the mill on the quality of domestic water supplies withdrawn downstream.[15]

Recent history in Nelson has demonstrated the resilience of a community faced with closure of resource industry operations. However, participants noted that Nelson's revitalization depends on historical restoration, tourism on the Kootenay lakes, and economic concentration associated with a governmental and regional distribution centre. These conditions are not so available to Castlegar, should the community have to cope with a shutdown of Celgar.

The importance of maintaining the current quality of life in the rural area of the west Kootenays was also emphasized by residents. The imposition of industrial development, with resulting environmental and social degradation, including greater chip truck traffic and timber harvesting, was perceived by some residents as a major threat to the stability of the rural communities.

Against this backdrop, participants urged wisdom in the arbitration of acceptable community standards for environmental, social and economic impacts.

The Panel recognizes the current value of Celgar to the region, and the increased economic advantages to the region of the proposed expansion. However, the Celgar mill is a

11. Castlegar Chamber of Commerce, Community Hearings Documents, 7, p. 3-4.
12. Ibid.
13. Castlegar Chamber of Commerce, op. cit., p. 3-6.
14. Ibid.
15. Mayor W. Trewhalla, Village of Warfield, Community Hearings Transcripts, Vol. 7, p. 73-4.

built to an outdated standard. Celgar argued that the investment in expansion of production is necessary to support the cost of modernized environmental controls. They estimated that they would need to spend at least $150 million in capital improvements for the current mill to meet existing environmental standards, without offsetting gains in production. Celgar does not consider investment in environmental controls, without expansion in production, to be viable. The proposal before the Panel is, therefore, the combined expansion of pulp production and environmental improvement.

Governments had made clear that Celgar would soon be required to meet environmental standards, with the current or expanded mill. The Panel believes that Celgar's proposal before us will meet environmental requirements. Given the acceptability of the project, it is also important to avoid the serious impact on the community which could result from Celgar's closure.

The Panel observed how knowledge of the environmental protection possible, which was gained through the hearings, reassured some participants. As participants learned about possible solutions to problems, there developed a spirit which could lead to working together. It will take great tolerance to reconcile values among these diverse communities. However, participants gave the Panel confidence that these communities will continue to thrive.

There is however, a need to continue the process of consulting interested members of the community about the impact of Celgar's plans and operations.

Recommendation 47

The Panel recommends that a "Columbia River Advisory Group," consisting of representatives of Celgar and responsible representatives of all communities affected by the mill, be established to review reports of Celgar's monitoring program, the Integrated Monitoring Program, and any related research from the Department of Fisheries and Oceans, the Canadian Wildlife Service, the British Columbia Ministry of Environment, and other bodies, and that this group advise Celgar and permitting authorities regarding further improvements to the environmental effects of the mill.

Although the focus of this "Columbia River Advisory Group" would be on environmental improvement, it would also offer a forum for consideration of other community impact issues to be referred to appropriate levels of government.

8.2 Construction Phase

8.2.1 Employment Impacts

The construction phase of the proposed new mill was projected to occur over a 27 month period and to create 2,343 person years of employment. The peak construction phase work force would occur in month 19 of the schedule, at which time more than 1,450 construction workers would be employed. The total employment impact on the British Columbia economy was estimated to be an additional 7,317 person years of employment.[16]

The company estimates that 30% to 40% of the direct construction work force can be supplied from the local "commuting shed", including communities such as Nelson, Salmo, Trail as well as Castlegar.[17] In terms of the mill construction, the proportion of local labour exceeds 50% of the total requirement during the first 11 months of construction and during the last 3 months. At the peak, it is estimated that approximately 1,000 persons working on the construction of the proposed mill expansion will consist of workers who are not residents of the Castlegar area.

Representation by local labour unions indicated that the jobs related to the construction would provide economic and social stability:

> It will give our membership the opportunity to enjoy some employment within driving distance of home, which has not been the case since 1980 on completion of the B.C. Hydro Seven Mile Dam. We have been turned into gypsies travelling over North America chasing employment for ourselves, some families following, some remaining behind, only to come home to find their children have moved elsewhere for some realm of stability.[18]

Additional jobs are anticipated due to local purchases during mill construction. Estimates by the company suggest that the local multiplier impact would be from 70 to 120 full time equivalent jobs. As well, the prospect of further employment opportunities through such projects as B.C. Hydro's Lower Columbia dam projects may promote further migration to the area.

8.2.2 Social and Community Impacts

The prospect of accommodating a peak of more than 1,000 in-migrant workers during the construction phase creates potential social and community impacts in the Castlegar area. Particular areas of concern identified by the company include: traffic safety and fiscal impacts of improvements to roads on the City of Castlegar, higher incidence of traffic and alcohol related crime and petty offenses, increased demand for public health inspections, emergency services, alcohol and drug abuse counselling, and mental health services.

Celgar suggested that potential adverse social and community impacts of the large in-migrant work force can be avoided or mitigated through the development of a construction camp at the site of the proposed new mill. The company also suggests that the scheduling of time off for the in-migrant work force, provision of various on-site facilities and social services, and the implementation of camp regulations will further lessen demands on local services and facilities and mitigate other community pressures associated with a large out-of-town construction work force.

16. Celgar Pulp Company, Stage II Reports, Vol. 5, "Socio-Economic & Archaeological Impact Assessments," Sec. 1, p. 74.
17. Mr. L. Parnell, Celgar Pulp Company, Technical Hearings Transcripts, Vol. 3, p. 622.
18. Mr. A. Miner, International Brotherhood of Electrical Workers Local 1003, Nelson, Community Hearings Transcripts, Vol. 2, p. 195.

The company's views of social and community impacts were disputed by some participants at the hearings. One intervenor suggested that the social impact assessment was deficient because it failed to assess the opinions of key organizations involved in the delivery of social services.[19] Others questioned the assumption that the provision of a construction camp would reduce pressures on the availability of housing in the Castlegar commuting shed. Some individuals at the Community Hearings expressed concern about the potential multiple impacts from the Celgar and B.C. Hydro projects.

Celgar recognized the need for community impact monitoring, particularly during the construction phase, but did not offer any specific mechanisms to address this requirement. The City of Castlegar recommended that social and economic impacts of the modernization be monitored throughout the construction phase by a committee consisting of affected local governments, provincial ministries and Celgar.[20] Provincial agencies also noted the significant potential impact on community services and suggested that a monitoring program be established.

Recommendation 48

The Panel recommends that a community liaison committee, comprised of representatives of local government and social service agencies, be established to improve communication among Celgar, contractors, government agencies, emergency services and the public, and to monitor and respond to community impact of the construction phase.

8.3 Infrastructure and Servicing

Celgar indicated that the municipal infrastructure, public utilities, schools, transportation, and legal services have adequate capacity to handle the increased work force, if expansion proceeds, with little or no impact expected. They acknowledged the need to participate in a coordinated effort with local and provincial authorities to address the necessary infrastructure improvements and safety compliance involved with increased trucking. Of particular concern are the potential aesthetic, safety and financial implications of increased road traffic along Columbia Avenue and Arrow Lakes Drive.

Concerning transportation, the City of Castlegar endorsed the construction of a bridge at Robson to alleviate truck traffic through the downtown corridor as well as improvements to the Brilliant interchange and the Robson/Pass Creek roads, improvements to the Highway 3/22 corridor and the upgrading of Columbia Avenue. Impacts on infrastructure, services and fiscal capabilities are currently being assessed by a comprehensive development planning process. This process, which will also address the transportation issue, is scheduled for completion by March 1991.

Increased sewage from the construction camp presents a possible concern due to the introduction of nutrients to the Columbia River. The construction camp, proposed to accommodate about 1,000 workers at peak periods, could result in an addition of 8.76 kg per day of nitrogen and 2.46 kg per day of phosphorus to the river, adding a 1.9 % increase in nitrogen and 2.4 % increase in phosphorus to the total nutrient loading of the proposed mill. While these are not large increases, it should be noted that relatively small increases in nutrient loadings to other large rivers, such as the Thompson, resulted in serious problems with attached algal growth.[21] A package sewage treatment plant is proposed to be installed to treat effluent from the construction camp. This effluent will be combined with the effluent from the existing mill at the foam tank.[22] Given the concerns about nutrient loading, the effects of additional nutrients from the camp should be carefully considered.

Recommendation 49

The Panel recommends that Celgar, in connection with the construction camp, be required to predict the effect of its sewage and waste water effluent on nutrient loading to the river, taking into account in-river attached algae tests (See also Recommendation 28), and that appropriate waste treatment be required to minimize undesirable attached algae and other aquatic vegetation growth in the receiving waters.

8.4 Archaeological Impacts

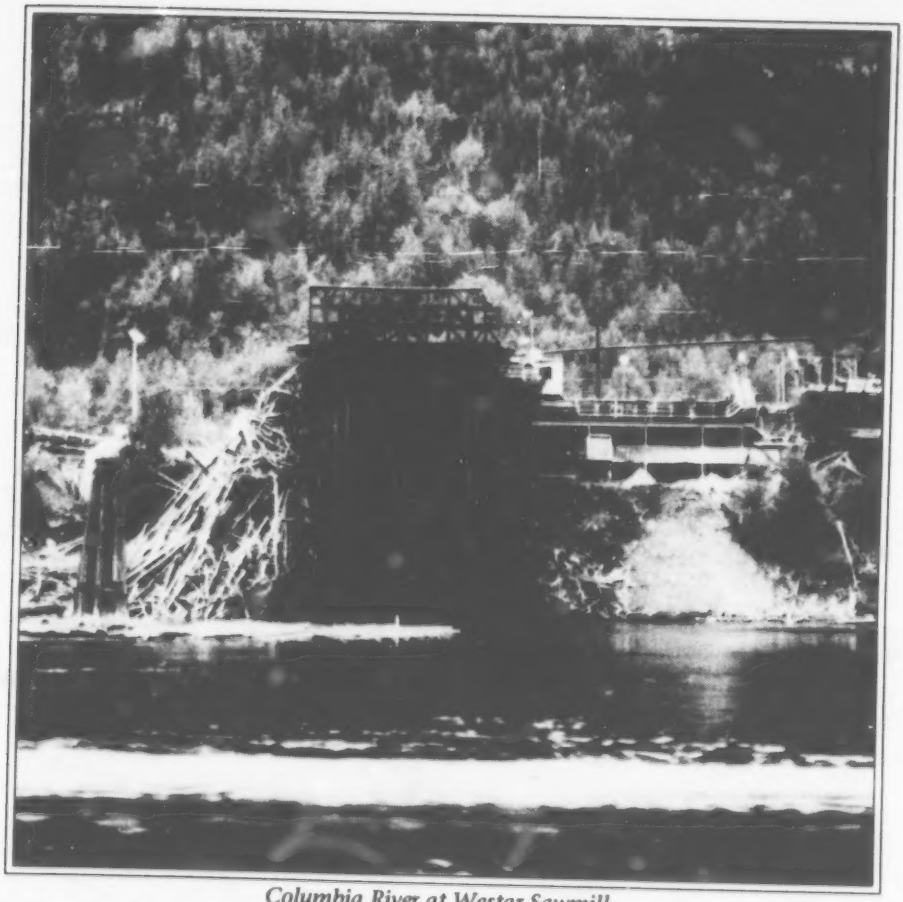
The archaeological impact assessment undertaken by Celgar's consultant indicated:

> ...that the proposed Celgar pulp mill expansion will not impact any known archaeological sites. The likelihood that the project will impact unidentified intact archaeological sites is nonexistent at the mill site and in the borrow pit at the proposed treatment plant.[23]

It was recommended that no further assessments be undertaken for the mill area, except for the borrow pit portion of the effluent treatment plant.

The assessment did identify a formation of potential paleoecological significance exposed in a vertical cut on the south edge of the borrow pit, where some excavations were planned for the effluent treatment plant. The 10 to 15 cm thick layer of volcanic ash was tentatively identified as part of the 6,600 year old Mazama ash fall.[24] Immediately below the ash layer is a 30 to 40 cm thick layer of sediment that apparently resembles an archaeological deposit. While the potential for an unidentified intact archaeological site was considered to be low, Celgar's consultant stated that "...any

19. Mr. M. Gilfillan, Community Hearings Transcripts, Vol. 2, p. 177.
20. Mayor A. Moore, City of Castlegar, Technical Hearings Transcripts, Vol. 10, p. 2479.
21. Dr. M. Bothwell, Department of Fisheries and Oceans, Technical Hearings Transcripts, Vol. 5, p. 1367-81.
22. Mr. L. Galloway, H.A. Simons Ltd., Written Communication to Celgar Pulp Company, November 9, 1990.
23. Celgar Pulp Company, op. cit., Sec. 2, p. ii,iii.
24. Celgar Pulp Company, op. cit., Sec. 2, p. 18.



Columbia River at Westar Sawmill.

site in association with volcanic ash or the possible palaeosol would be of very high scientific significance because of its antiquity."[25]

Celgar's consultant recommended that excavation of the terrace remnant for the proposed effluent treatment plant be monitored by a qualified archaeologist, and that the excavation contractor be notified of the monitoring and advised that excavation could be delayed or halted if significant archaeological remnants were encountered.

The field research methods employed to undertake the archaeological assessment were criticized. The assessment was conducted during late winter, when snow cover obscured any potential archaeological remains and the frozen ground precluded shovel tests.[26] Concerns also were expressed that no further archaeological assessment of the mill site was recommended, particularly as maps indicated a stream bed above the current mill and the assessment noted a possibility for early settlement at stream mouths.

In response to the above concerns, Celgar's consultant stated that substantial past disturbance precluded finding archeological remains in all of the area where development is proposed except for an area adjacent to the effluent treatment pond and that even this portion had low potential for an intact archeological site.

The Panel concludes that there is a low probability of archaeological sites but that monitoring of excavations by a qualified archaeologist is warranted.

Recommendation 50

The Panel recommends that site specific archaeological monitoring of excavations be undertaken in consultation with provincial government archaeologists.

25. Celgar Pulp Company, op. cit., Sec. 2, p. iii.
26. Dr. M. Mealing, Technical Hearing Transcripts, Vol. 3, p. 734.

Chapter 9: Comments On The Review Process

The Celgar Expansion Review Panel was the first to operate under both the British Columbia Major Project Review Process and the Federal Environmental Assessment and Review Process Guidelines.

The following comments are based on the Panel's experience. Their intent is to allow governments and review panels which follow to take advantage of what we learned.

9.1 Legal Framework

The current legal framework for the conduct of independent enquiries makes it essential for review panels to build their processes on the most competent of legal advice, particularly with respect to administrative law. Procedures must meet a rigorous test of fairness in receiving public representation and in allowing parties affected by the panel's recommendations the opportunity to consider and respond to all representation before a panel.

The Celgar Expansion Review Panel's extensive hearing process was driven by the Panel's care to interpret these requirements in ways which would enable participants the full benefit of an independent public review, and which would result in well informed conclusions available to government decision makers.

As the legal framework for environmental assessment panels imposes greater demands on participants, the counsel to such panels has a role in informing participants of their responsibilities.

The Celgar Panel took the approach of depending on the Panel's counsel to lead the proceedings on the Panel's behalf, to protect the integrity of the process. The Panel, however, believed that direct dialogue with interested parties was essential to the Panel's understanding. Technical presentations were made by experts, and the Panel questioned participants directly. The result was a structured, but fairly informal style, focused on the information required by the Panel.

9.2 Hearing Procedures

The Panel's hearing procedures were designed to structure participants' presentation of material, which ranged from the highly emotional to the most technical. For the most part, participants appreciated the opportunity for the Panel to receive information, make it available to the public in advance, review it, and question participants sufficiently to inform the Panel's judgement about the acceptability of Celgar's proposal.

The content of the Technical Hearings was structured by subject to enable participants to predict which session would require particular experts.

The Community and Technical Hearings provided valuable education to the Panel and to all participants. It was important that participants feel free to make their views known to t Panel, no matter what the participant's position or previo experience in making presentations to such bodies.

Because the hearing process was new, and the Panel w not appointed until seven months after the beginning of t province's Stage I review, there was initially both confusi and skepticism in the communities about the process. T public had not had the opportunity to meet the Panel as t issues of concern to them were identified during Stage I, often happens in the "scoping" stage of a federal EARP.

All participants, including the proponent, needed to devel confidence that their views would be heard with respect a taken seriously.

This experience suggests that appointment of the revi panel earlier in the process might have lessened the build of tensions which occured in the communities affected Celgar's proposal. This could be partly overcome in the futu by recognition, at the outset of the Major Project Revi Process, that there will be an opportunity to appear before independent review panel.

9.3 Makeup of the Panel

The Panel's understanding was enriched by membe depth and range of experience directly relevant to the Cel proposal. It is essential that review panels base th recommendations on scientific evidence, and be persona equipped to interpret the most advanced of scient knowledge. They must also have direct understanding commercial and public policy considerations which aff such a project.

The Panel could have benefitted from a still wider range knowledge, experience and personal values brought to Panel's own decision making. This could be accomplished one or two more members, although a much larger pa would be unmanageable. This Panel felt small at times.

9.4 Local Involvement

The local perspective of a Panel member from community would be valuable. In the absence of a lo member drawn from the community, it is essential t review panels extend their own personal knowledge of areas affected and the range of communities where heari are convened.

The Panel and staff found it essential to become acquain early with the area by travelling the river by boat, visiting communities, driving the highways and touring the mill would have been useful to extend this exploration into m direct contact with sawmilling and logging operations, perhaps to have flown over the valleys. One of

the constraints on such direct contact is the need to avoid receiving representation of local views outside the public hearings.

The establishment of a local presence, through a Castlegar office and the constant efforts of the Executive Secretary and staff, was of much importance to participants and the Panel. There was heavy use of the toll-free number. Material in reference centres, and frequent newsletters kept people in all communities informed. The Panel attached a great priority to communication with people in the affected communities.

As a direct result of this local contact, the Panel was aware of the importance of Community Hearings in Nelson, Slocan, Nakusp and Trail, as well as Castlegar. Residents of Silverton appreciated the Panel's agreement to their request for a hearing there.

9.5 Media Involvement

The cooperation of the local media was extremely helpful, both informing residents in advance of the hearings, and providing full coverage of the issues at the hearings. There was intense interest in communities affected by Celgar's proposal, and the media responded by fully informing those people who were unable to attend the hearings.

9.6 Educational Material

Given the educational value of the hearings, it is regrettable that the Panel or governments did not plan in advance to capture the hearings on video tape. A number of interested parties taped the hearings. Material would likely be available if there was a desire to produce educational material. Subjects like pulp mill environmental control processes, water and air quality, the effect of toxins (like dioxins and furans) on wildlife, and forest ecology are examples where general public interest is high, and experts offered the Panel scientific knowledge which people need to understand about environmental risks and how to minimize them. It would be important, however, to recognize the considerable cost of producing professional video material from unedited tapes.

9.7 Timing Considerations

Review panels, of necessity, operate within the commercial context which faces development projects subject to environmental and social review. Panels have the responsibility to proceed with despatch. However, governments, proponents and affected communities must expect that competent, thorough, independent reviews need the freedom from externally imposed deadlines. This is not to discount the importance of commercial discipline, but rather a caution against setting unrealistic deadlines.

In Celgar's case, because the proposal in question related to an operating mill, the community was aware that it faced possible closure if Celgar could not comply with environmental standards. No one's interest was served, however, by fostering hysteria in the community about cancellation of the project or closure of the mill.

If there are material constraints facing proponents, panels should be formally given that information from the outset. Panels still must decide what review process is necessary, but such information is important for them to take into account.

9.8 Mandate of the Panel

The Panel's Terms of Reference were limited with regard to forest management and certain aspects of transportation. These limitations were frustrating to participants and to the Panel, because the excluded issues were so closely interrelated with those the Panel was required to consider.

9.9 Resources

The Panel recognized the importance of economy in the conduct of the review process. However, governments must make available the funds and administrative support necessary to the task.

The Executive Secretary faced responsibilities of heroic proportions. This Panel enjoyed the support of an outstanding Executive Secretary and governments should attach great importance to the selection of panel staff with the competence and in the numbers necessary. Executive Secretariats should include a director of research, and have greater access to technical consultants, and administrative capacity. This would require more dedicated personnel than one Executive Secretary but not necessarily a full time staff. With the benefit of hindsight, knowing what was asked of the Executive Secretary, the Panel should have augmented staff from the outset.

Appendix 1: Celgar Review Panel Terms of Reference

BACKGROUND

Celgar Pulp Company is proposing to expand its bleached kraft pulp mill on the Columbia River, at Castlegar, British Columbia. The company operates as a joint venture between CITIC B.C. Inc. and Power Consolidated (China) Pulp Inc.

The Celgar project is currently subject to British Columbia's Major Project Review Process (MPRP). Celgar filed an Environmental Impact Assessment report as a Prospectus with the Major Project Steering Committee (MPSC) in December 1989; a socioeconomic report was subsequently filed in January 1990. Provincial and federal environmental agencies have been major participants in the review process, and the reports have also been forwarded to local government, public interest groups, public libraries in the West Kootenays and to government agencies and interest groups in the State of Washington. Upon completion of the Prospectus review, the MPSC determined that a Stage II submission was necessary to address a number of concerns identified during the Prospectus review.

In view of public concerns over the potential environmental impacts of the project, an independent review Panel has been formed. This Panel is established under Section 7 of the British Columbia Environmental Management Act and pursuant to the federal Environmental Assessment and Review Process (EARP) Guidelines Order with the federal Department of Fisheries and Oceans being the initiating department. The Panel is expected to complete the Stage II public review requirements of the provincial MPRP and, at the same time, to fulfil the federal government's requirements and responsibilities under its Environmental Assessment and Review Process. The terms of reference for the Panel have been approved by the provincial Minister of Environment and by the federal Minister of Environment.

PANEL MEMBERSHIP

The panel is comprised of a chairman and two additional members. All three panelists are joint appointments made by the provincial Minister of Environment and the federal Minister of Environment.

PANEL MANDATE

The Mandate of the Panel is to conduct a public review of the environmental and associated social effects of the proposed Celgar Pulp Expansion Project, including any effects that are external to Canadian territory. The primary concerns which have emerged from the project review to date have been connected with the protection of ambient air and water quality, including fish and fish habitat, the availability of surplus wood chips and the impact of additional truck traffic resulting from the transportation of additional wood chips to the mill. The Panel shall focus its review on these concerns.

The impact of the project on the management of provincial Crown forests is not included in the mandate of the Panel. The Company does not possess any rights to harvest timber on Crown forest land and, therefore, purchases its wood fibre requirements from manufacturing operations which have surplus wood fibre supply. The company has stated that all of its wood fibre requirements for the expanded mill operation can be met through accessing by-product chips from area sawmills and from pulp logs produced as a by-product of the area's sawlog harvest. Therefore, the mill expansion proposal is not contingent upon the company securing new sources of fibre supply requiring new timber harvesting agreements.

In fulfilling its mandate, the Panel shall:

1. Conduct public hearings to be held in Castlegar and one or more neighbouring communities;
2. Review the Company's Stage II submission and Prospectus documents and any other written material it deems relevant;
3. Provide for public access to all information provided to or prepared by it; and
4. Prepare a written report with recommendations to the provincial Minister of Environment and the federal Ministers of Environment and Fisheries and Oceans. Recommendations shall be provided on the environmental acceptability of the proposed pulp mill expansion.

The review undertaken to date shall be considered sufficient for the purpose of identifying and determining the scope of the issues raised by the project and, therefore, the Panel is not required to undertake an "issues scoping" step in its review.

If the Panel concludes that the proposal is acceptable, it shall explain the basis for that conclusion and recommend terms and conditions under which the expansion could proceed. If the Panel concludes that the proposal is unacceptable, it shall similarly explain the basis for this conclusion.

No construction activities on the site associated with this mill expansion proposal shall be initiated until after the Panel has completed its review, and then, only if the governments' decision is to allow the proposal to proceed and the proponent has obtained the necessary statutory authorization for commencement of construction.

PANEL REVIEW STAGES

The main stages in the Panel review process shall be as follows:

1. The Panel shall review the Prospectus documents and comments of the public and of provincial and federal agencies resulting from the Prospectus review;
2. The Panel shall ensure wide public distribution of the Stage II submission;
3. The Panel shall invite comments in writing from all interested parties, including federal and provincial agencies, on the Company's Stage II submission within 45 days from the distribution of the Stage II submission;
4. The Panel shall ask the Company as soon as possible to provide supplemental information, if any deficiencies are identified during its review of the Stage II submission;
5. At its discretion, the Panel may also direct specific information requests to federal and provincial agencies;
6. The Panel shall schedule its public hearings as soon as it is satisfied that it has an adequate information base for discussion at the hearings;
7. Public hearings shall be held by the Panel in Castlegar and one or more neighbouring communities. The hearings will be non-judicial, but will be governed by clear rules of procedure;
8. At its discretion, the Panel may prepare a short interim report shortly after completion of the hearings with recommendations on whether or not approval-in-principle for the Project should be granted. This report will be submitted to the provincial Minister of Environment and the federal Ministers of Environment and Fisheries and Oceans;
9. The Panel shall prepare a final report with complete recommendations, and submit this to the provincial and federal Ministers; and,
10. Following review of the Panel report by the two governments, the report and the governments' decision on the project will be made public.

PROCEDURES

Detailed written procedures for the conduct of the review, including the public hearings shall be established by the Panel and made available to the public as expeditiously as possible. These operational procedures will be submitted to and approved by the Executive Chairman of the Federal Environmental Assessment Review Office and the Deputy Minister of the B.C. Ministry of Environment.

TECHNICAL SPECIALISTS

As deemed necessary and appropriate by the Panel, technical specialists may be engaged to assist with the examination and understanding of specific issues. At the discretion of the Panel, these individuals may be made available to other review participants to assist with their understanding of these issues. The Panel's procedures shall contain further detail on the role and availability of these specialists.

SECRETARIAT

A Secretariat shall be established to assist the Panel with day-to-day management of its activities.

APPENDIX 2: PUBLIC REFERENCE CENTRES

The following locations were established as public reference centres for key documents.

Castlegar & District Library
1005-3rd St.
Castlegar, B.C.

Selkirk College Library
301 Frank Beinder Way
Castlegar, B.C.

Nelson Library
719 Vernon St.
Nelson, B.C.

Rossland Public Library
2180 Columbia
Rossland, B.C.

Nakusp Public Library
92-6th Ave. West
Nakusp, B.C.

City of Revelstoke
216 Mackenzie Ave.
Revelstoke, B.C.

Village of New Denver
Office
New Denver, B.C.

Kaslo Public Library
413-4th St.
Kaslo, B.C.

Village of Salmo Office
444 Baker St.
Salmo, B.C.

Village of Slocan Office
503 Slocan
Slocan, B.C.

Trail & District Library
1051 Victoria St.
Trail, B.C.

Kettle Falls Public Library
Kettle Falls, Washington
U.S.A.

Vancouver Public Library
750 Burrard St.
Vancouver, B.C.

Celgar Expansion Review
Panel Office
1414 Columbia Ave.
Castlegar, B.C.

Colville Public Library
195 South Oak
Colville, Washington
U.S.A.

APPENDIX 3: LIST OF PRESENTATIONS

COMMUNITY HEARINGS

Castlegar, September 20, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
   Mr. H. Gairns
   Mr. P. Levelton
   Dr. L. Galloway
   Dr. G. Vigers
   Mr. P. Sagert
   Mr. J. Browne
   Mr. D. Hildebrand
2. Mr. C. Evans
3. Pope and Talbot Ltd.
   Mr. A. Friesan
4. Celgar Pulp Co. Accounting Group
   Mr. L. Anderson
5. Medical Clinic of Castlegar and Kinnaird
   Dr. R. Ward
6. Pulp, Paper and Woodworkers Union, Local 1
   Mr. B. Brommeland
   Mr. P. Donahue
   Mr. K. Carlson
   Mr. C. Him
7. Ms. M. Strong
8. Celgar Pulp Co. Material Handling Dept.
   Mr. B. Carlson
9. Castlegar and District Development Board
   Mr. H. John
10. Mr. P. Johnstone
11. Mr. F. Ruljanich and Mrs. L. Ruljancich
12. Mr. D. McDowell
13. Castlegar Chamber of Commerce
    Mr. J. Craig
14. Mr. R. Lowe
15. Celgar Pulp Co. Maintenance Management Staff
    Mr. T. Moon
16. Ms. D. Martini
17. Mr. R. Collier
18. Mr. G. Brady
19. City of Castlegar
    Mayor A. Moore
    Mr. G. Williams
20. Ms. D. Bruce
21. Adastra Aviation
    Mr. D. Nielson
22. Mr. T. Smith
23. Society of Management Accountants of B.C.
    Ms. J. Hamilton
24. Mr. D. Nielson
25. Mr. I. K. Barber
26. Citizens for a Clean Celgar Modernization
    Mr. D. Donaldson
27. Kalesnikoff Lumber
    Mr. P. Kalesnikoff
28. Mr. R. Retzloff
29. Mr. E. Conroy

Castlegar, September 21, 1990

1. Central Kootenay Health Unit
   Dr. N. Ames
2. United Steel Workers of America
   Mr. R. Schmidt
3. Mrs. B. Horswill
4. Dr. M. Mealing
5. IWA Canada, Local 1405
   Mr. K. Offerman
6. Ms. M. Johnstone
7. Mr. C. Henne
8. Mr. R. Armbruster
9. Ms. N. Collier
10. Mr. B. Pottle
11. Mr. F. March
12. Mr. T. Dalton
13. Mr. C. D'Arcy
14. Mr. B. Foubister
15. Mr. D. Lewis
16. Mr. C. Him
17. Westcoast Environmental Law Association
    Ms. A. Hillyer
    Representating:
    - Active Malaspina Mariculture Association
    - Alberni Environmental Coalition
    - Arrowsmith Ecological Association
    - B.C. Coalition for Alternatives to Pesticides
    - B.C. Council of the Confederation of Canadian Unions
    - B.C. Public Interest Research Group
    - B.C. Wildlife Federation
    - Bowan Island Improvement Association
    - Campbell River Environmental Council
    - Canadian Association of Industrial
    - Mechanical and Allied Workers
    - Canadian Paperworkers Union, Local 1119
    - Canadian Paperworkers Union, Local 76
    - Citizens Public Affairs Association
    - Community Learning Services for a Sustainable Future
    - Consumer Association of Canada
    - B.C. Branch, David Suzuki
    - Earth Care Society
    - East Kootenay Environmental Society
    - Environmental Watch
    - Friends of Ecological Reserves
    - Friends of Porter Island
    - Friends of Strathcona Park
    - Friends of the Athabasca Environmental Association
    - Friends of the Peace
    - Greenpeace Foundation of Canada
    - Health Action Network
    - International Woodworkers of America-Canada
    - Nechako Environmental Coalition
    - New Westminster Citizens Association
    - North Cowichan Environmental Protection Group
    - Northwest Wildlife Preservation Society
    - Ocean Resource Conservation Alliance
    - Paper Choice
    - Powell River Anti-Pollution Association
    - Provincial Council of Women
    - Pulp, Paper & Woodworkers of Canada
    - Quadra Resort
    - Quesnel and District Citizens for a Clean Environment
    - Raging Grannies
    - Safe Howe Sound Society
    - Sierra Club of Saltspring Island
    - Sierra Club of Western Canada
    - Silva-Ecosystem Consultants
    - Society Promoting Environmental Conservation
    - Steelhead Society
    - Sunshine Coast Environmental Protection Project
    - Thompson Watershed Coalition
    - Totem Flyfishers
    - Toxic Watch
    - United Fishermen & Allied Workers Union
    - Valhalla Wilderness Society
    - Western Canada Wilderness Committee
18. Mr. K. Chernoff
19. Mr. T. Thompson
20. Ms. W. Hurst
21. Mr. E. Pellerine
22. Mr. A. Roberts
23. Mr. G. Stein
24. Mr. M. Gilfillan
25. Mr. H. Killough
26. Mr. T. Larson
27. International Brotherhood of Electrical Workers, Local # 1003
    Mr. A. Miner
28. Mr. P. Oglow
29. Mr. F. Ruljancich
30. Mr. H. Killough

Nelson, September 22, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
   Dr. L. Galloway
   Mr. V. Morandini
   Mr. B. Briscoe
   Mr. G. Vigers
   Mr. T. Barker

2. Mr. H. Pendergast
3. Mr. R. Eggers
4. West Kootenay Forestry Alliance
   Mr. R. MacLeod
5. Mr. G. Retterath
6. International Brotherhood of Electrical Workers
   Mr. B. McKnight
7. Valhalla Society
   Mr. G. Copeland, Ms. A. Sherrod
8. Mr. M. Adams
9. West Arm Watershed Alliance
   Mr. R. Bridge
10. Ms. P. Bossort
11. Mr. A. Dodsworth
12. Celgar Pulp Company Chip Handling Department
    Mr. J. Williams
13. Slocan Valley Watershed Alliance
    Mrs. S. Hammond, Mr. H. Hammond
14. Ms. C. Burton
15. Kootenay Lake Watershed Alliance
    Mr. G. Utzig
16. Mr. G. Becker
17. Mr. T. Lowrey
18. Mr. D. Cornish
19. Mr. D. Horner
20. Mr. H. Boyes
21. Mr. J. Coyle
22. Mr. P. Ziskind
23. Mr. M. Dibella
24. Ms. M. Wells
25. Ms. S. Mitchell
26. Mr. D. Duncan
27. Mr. J. Shecter
28. Harrop-Proctor Watershed Protection Committee
    Ms. L. Whonnock

Slocan, September 24, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
   Mr. P. Levelton
   Mr. T. Barker
2. Slocan Village Council
   Mayor D. Betts
3. Mr. G. Elder
4. Mr. H. Leslie
5. Ms. B. Clayton
6. Mrs. L. Schindel
7. Mr. J. Schindel
8. Mr. B. Connelly
9. Mr. W. Hicks
10. Ms. C. Connelly
11. Ms. L. Kaufmann
12. Mr. P. Kaufmann
13. Mr. D. Orcutt
14. Mr. D. Visser
15. Mr. K. Del Puppo
16. Mr. C. Lawrence
17. Mr. N. Morris
18. Mr. G. Zaitsoff
19. Ms. L. Mandala
20. Mr. B. Burgoon
21. Mr. L. Avis

Silverton, September 25, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
2. Village of Silverton
   Mayor R. Hardy
3. Village of New Denver
   Alderman P. Peterson
4. Mr. H. Wilson
5. Community School Association
   Ms. J. Taylor
6. Coalition for Pulp Mill Accountability
   Ms. A. Wright
7. Environmental Youth Alliance
   Mr. T. Monnastes
8. Coalition for Pulpwood Accountability
   Ms. D. LaCroix
9. Red Mountain Residents' Association
   Mr. B. Varaleau
10. Ms. L. Wilson
11. Ms. B. McNeil
12. Ms. K. Monnastes
13. Ms. S. Hammond (presented by Ms. W. Harlock)
14. Ms. L. Obermeyer
15. Kootenay Natural Tofu
    Mr. T. Hook
16. Ms. E. Goodell
17. Mr. G. Hunter
18. Mr. J. Herman
19. B.C. School Trustees' Association
    Ms. D. DeAngelo
20. Mr. K. Ormrod
21. Mr. D. Herreshoff
22. Slocan District Chamber of Commerce
    Mr. B. Nielson

Nakusp, September 25, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
2. Village of Nakusp
   Deputy Mayor L. Beingessner
3. Downey Street Sawmills
   Mr. J. Heavenor
4. B.C. Trucking Association
   Mr. R. Weston
5. Slocan Valley Watershed Alliance
   Mr. R. Allen
6. Mr. G. Haughland
7. Revelstoke Chamber of Commerce
   Ms. D. Peebles-Adams
8. City of Revelstoke
   Mr. D. Weir
9. Ms. C. Bowman
10. Boundary Transportation
    Mr. J. Meade
11. Arrow Lakes Environmental Alliance
    Mr. E. Van Houten
12. Chambers Trucking Ltd.
    Mr. D. Chambers
13. Mr. F. Maltby
14. Evans Forest Products Ltd.
    Mr. W. Schmirler
15. Westar Timber
    Mr. D. Madlan
16. Ms. B. Bowman
17. Mr. J. Robertson
18. Mr. T. O'Brien

Trail, September 26, 1990

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
2. City of Trail
   Mayor M. Marcolin
3. Ms. K. Just
4. Mr. H. Lowe
5. Mr. W. Siemens
6. Economic Development Commission of Greater Trail
   Mr. M. Kruysse
7. Ms. I. Golebiowski
8. Mr. T. Carver
9. Fame Construction
   Mr. P. Ferro
10. Mrs. B. Middleton
11. Mrs. B. Ross
12. Mr. S. Leyland
13. Mr. G. Evans
14. Mr. R. Nelson
15. Village of Warfield
    Mayor W. Trewhella
16. Mr. J. Meyer
17. Emco Engineering
    Mr. R. Ross
18. B.C. and Yukon Territory Building and Construction Trades Council
    Mr. J. Lipperts
19. Ms. E. Peterson
20. Green Party of B.C.
    Ms. A. Price
21. Citizens for Clean Celgar Modernization
    Mrs. D. Bagg
22. Bedrock Logging Company
    Mr. F. Peitzche
23. Mr. R. Maddocks
24. Mr. E. Kytonen
25. NRS Mountainview Agencies
    Mrs. T. Wilson
26. Mr. J. Williamson
27. Mr. E. Burg

TECHNICAL HEARINGS

Castlegar, October 18, 1990 – Wood Chip Supply

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
   Mr. H. Gairns
2. Westar Timber Ltd.
   Mr. D. Madlung
3. Mr. F. Ruljancich
4. Mr. S. Leyland
5. Ministry of Forests
   Mr. J. Juhasz, Mr. V. Holm
6. Department of Fisheries and Oceans
   Mr. J. Payne, Mr. R. Travers
7. Mr. J. McWilliams

Castlegar, October 19, 1990 – Transportation

1. Celgar Pulp Company
   Mr. L. Parnell
   Mr. P. Levelton
   Mr. D. Mills
2. Mr. D. Hildebrand
3. Kootenay Coalition for and EARP
   Dr. T. Heavor
4. Boundary Transportation
   Mr. J. Meade
5. Slocan Valley Watershed
   Mr. B. Lerch
6. Transport Canada
   Mr. K. Kavanagh
   Mr. R. Watkin
7. Ministry of Transportation and Highways
   Mr. G. Sutherland
   Mr. K. Rockerby
   Mr. D. Barcham
8. Mr. P. Roer and Mr. B. Partington

Castlegar, October 20, 1990 – Community Issues

1. Celgar Pulp Company (including persons making opening presentations and/or closing remarks)
   Mr. L. Parnell
   Mr. D. Hildebrand
2. City of Castlegar
   Mr. G. Williams
3. DPA/Castlegar Chamber of Commerce
   Mr. J. Craig
4. Dr. M. Mealing
5. Mr. F. Ruljancich and Mrs. L. Ruljancich
6. Mr. R. Barkley

Castlegar, October 25, 1990 – Pulp Mill Process

1. Celgar Pulp Company
   Dr. L. Galloway
   Mr. W. Mackay
   Mr. B. Briscoe
   Mr. N. Dinsmore
   Mrs. J. Grabovac
   Dr. G. Vigers
   Mr. P. Deutsch
   Dr. M. Paine
   Dr. D. Jeffries
   Dr. B. Willis
2. Pulp, Paper and Woodworkers Union, Local 1
   Mr. C. Him
3. Department of Fisheries and Oceans/Environment Canada
   Mr. M. Nassichuk
   Mr. D. McIlroy
   Dr. L. Lockhart
   Dr. J. Carey
   Dr. D. Muir
   Dr. J. Servizi
   Dr. M. Bothwell
   Mr. B. Thomson
4. Ministry of Environment
   Mr. D. McDonald
   Mr. C. Johnson
   Mr. R. Crozier
   Mr. R. Bennett
   Mr. J. van Barneveld
   Mr. J. Hammond
   Mr. J. McLaren
   Mr. L. Linewebber
5. Kootenay Coalition for an EARP
   Dr. M. O'Brien

Castlegar, October 26, 1990 – Water Quality and Fisheries

1. Dr. D. Schindler
2. Department of Ecology of the State of Washington
   Mr. D. Burhalter
   Mr. A. Johnson
3. Department of Fisheries and Oceans/Environment Canada (refer to Castlegar, October 25 list of presenters)
   Mr. H. Liebshner
   Dr. H. Mundie
   Mr. P. Whitehead
4. Ministry of Health
   Dr. N. Ames
5. Ministry of Environment
   Mr. D. McDonald
   Mr. R. Crozier
6. Mr. M. Bronaugh
7. Dr. Stryd

Castlegar, October 27, 1990 – Pulp Mill Process, Water Quality and Fisheries

1. Celgar Pulp Company
   Mr. L. Parnell
   Mr. H. Granath
2. B.C. Hydro
   Mr. P. Calder
3. Cominco
   Mr. G. Kenyon
4. Dr. C. DeMarco
5. Dr. M. Mealing
6. B. C. Ministry of Environment
   Mr. J. Hammond
7. Pulp, Paper and Woodworkers Union, Local 1
   Mr. B. Reiter
8. Westwater Research Centre/ McLeay Associates Ltd.
   Dr. K. Hall
   Mr. M. Gordon
9. Celgar Pulp Company
   Mr. L. Parnell
   Mr. H. Hargback
   Mr. B. Prough
   Dr. G. Vigers
   Dr. L. Galloway
   Dr. S. Turk
   Dr. E. Jeffries
   Mr V. Morandini
   Mr. J. Browne
   Mr. W. McKay
   Dr. M. Paine

Castlegar, October 28, 1990 – Water Quality and Fisheries

1. Celgar Pulp Company
   Dr. G. Vigers
   Mr. P. Deutsch
   Dr. M. Paine
   Dr. R. Peters
   Dr. R. Peterman
   Mr. V. Morandini
   Mr. H. Hargback
   Dr. L. Galloway
   Dr. S. Turk

Castlegar, November 1, 1990 – Air Quality

1. Kootenay Coalition for an EARP
   Mr. H. Hammond
2. Celgar Pulp Company
   Mr. L. Parnell
   Mr. B. Briscoe
   Mr. P. Sagert
   Mr. R. Nogami
   Mr. E. Hovind
   Dr. E. Jeffries
   Dr. S. Linzon
   Dr. M. Ruby
3. Pulp, Paper and Woodworkers Union
   Mr. C. Him
   Mr. F. Hinton
4. Mr. R. Lowe
5. Environment Canada
   Mr. F. Mah
   Mr. B. Thompson
   Mr. D. Poon
6. Ministry of Environment
   Mr. R. Crozier
   Dr. R. Bennett
   Mr. J. van Barneveld
7. Dr. N. Thyer
8. Ministry of Environment
   Mr. J. van Barneveld
   Dr. R. Bennett
   Mr. C. Johnson
9. Dr. F. Murray

Closing Statements

1. Closing Statement of Ministry of Environment
   Mr. D. McDonald
2. Closing Statement of Pulp, Paper and Woodworkers Union
   Mr. C. Him
3. Closing statement of Kootenay Coalition for an EARP
   Mr. K. McGee
   Representing:
   - Slocan Valley Watershed Alliance
   - West Arm Watershed Alliance
   - East Shore Forest Council
   - Guiding Hands Recreation Society
   - Grand Forks Watershed Coalition
   - East Kootenay Environmental Society
   - Christina Lake Watershed Alliance
   - Argenta Monthly Meeting
   - Argenta/Johnson's Landing Forestry Committee
   - Lardeau Valley Organic Growers Association
   - Kootenay Lake Chamber of Commerce
   - Pro Terra
   - Non Violence Resource Centre
   - Thompson Watershed Coalition
   - Kootenay Society for a Sustainable Future
   - Shuswap Forest Watch Committee
   - Arrow Lakes Environmental Alliance
   - Rosslanders Advising Council on the Environment
   - Trail District Environmental Network
   - Coalition for Pulp Mill Accountability
   - Valhalla Wilderness Society

APPENDIX 4: LIST OF DOCUMENTS AND SUBMISSIONS

I. PUBLIC FILE DOCUMENTS 86
A. CORRESPONDENCE AND SUBMISSIONS 86
B. GOVERNMENT CORRESPONDENCE AND REPORTS 90
C. OTHER MATERIALS 91

II. DOCUMENTS PREPARED FOR OR ON BEHALF OF CERP 91

III. DOCUMENTS AND CORRESPONDENCE PREPARED BY OR ON BEHALF OF CELGAR PULP COMPANY 91

IV. COMMUNITY HEARING DOCUMENTS 92
September 20, 1990 - Castlegar
September 21, 1990 - Castlegar
September 22, 1990 - Nelson
September 24, 1990 - Slocan
September 25, 1990 - Silverton/Nakusp
September 26, 1990 - Trail

V. TECHNICAL HEARING DOCUMENTS 93
October 18, 1990 - Wood Chip Supply
October 19, 1990 - Transportation
October 20, 1990 - Community/Archaeological Considerations
October 25, 1990 - Pulp Mill Processes/ Water Quality and Fisheries
October 26, 1990 - Water Quality and Fisheries
October 27, 1990 - Water Quality and Fisheries
November 1, 1990 - Air Quality
Other Technical Hearing Submissions

VI. FINAL SUBMISSIONS 94

I. Public File Documents

A. Correspondence and Submissions

1. Valhalla Society - Position Paper on Pulpwood Agreement No. 9, July 5, 1990.
2. Letter from R. Rogers, with Copy of Letter to MLA Dirks, July 16, 1990 and July 18, 1990.
3. Letter from Slocan District Chamber of Commerce, July 23, 1990.
4. Letter from Mr. D. MacKinnon, July 27, 1990.
5. Letter from Mr. R. Walley, July 27, 1990.
6. Letter from Ms. H. Walley, July 27, 1990.
7. Letter from Ms. J. Command, July 27, 1990.
8. Letter from Mr. E. Johnson, July 28, 1990.
9. Letter from Mr. B. Ramsay, July 28, 1990.
10. Letter from Ms. B. Worsnop, July 28, 1990.
11. Letter from Mrs. N. Vorkin, July 28, 1990.
12. Letter from Ms. D. Soobotin, July 28, 1990.
13. Letter from C. Nolan, July 28, 1990.
14. Letter from G. Carson, July 28, 1990.
15. Letter from J. Makeiv, July 28, 1990.
16. Letter from Mrs. D. Stolz, July 28, 1990
17. Letter from Mrs. I. Postnikoff, July 28, 1990.
18. Letter from Mr. A. Kelley, July 28, 1990.
19. Letter from Mr. A. Robertson, July 28, 1990.
20. Letter from Mr. A. Wzedia, July 28, 1990.
21. Letter from Mr. B. Prediger, July 28, 1990.
22. Letter from Mr. B. Vecchio, July 28, 1990.
23. Letter from Mr. C. Aiken, July 28, 1990.
24. Letter from Mr. G. Porter, July 28, 1990.
25. Letter from Mr. J. Stooshnoff, July 28, 1990.
26. Letter from Mr. K. Juel, July 28, 1990.
27. Letter from Mr. L. Bernard, July 28, 1990.
28. Letter from Mr. L. Doskoch, July 28, 1990.
29. Letter from Mr. M. Vecchio, July 28, 1990.
30. Letter from Mr. N. Flinterberger, July 28, 1990.
31. Letter from Mr. T. Barnes, July 28, 1990.
32. Letter from Mr. W. Thomsen, July 28, 1990.
33. Letter from Ms. B. Demaskoff, July 28, 1990.
34. Letter from Ms. C. Barsloff, July 28, 1990.
35. Letter from Ms. C. Fromsu, July 28, 1990.
36. Letter from Ms. C. Waage, July 28, 1990.
37. Letter from Ms. D. Daskoch, July 28, 1990.
38. Letter from Ms. D. Edwards, July 28, 1990.
39. Letter from Ms. D. Edwards, July 28, 1990.
40. Letter from Ms. F. Ratcliffe July 28,1990
41. Letter from Ms. H. Bennett, July 28, 1990.
42. Letter from Ms. I. Browning, July 28, 1990.
43. Letter from Ms. L. Jennings, July 28, 1990.
44. Letter from Ms. L. Will, July 28, 1990.
45. Letter from Ms. M. Williamson, July 28, 1990.
46. Letter from Ms. P. Verzuk, July 28, 1990.
47. Letter from Ms. T. Wiesner, July 28, 1990.
48. Letter from Ms. V. Penson, July 28, 1990
49. Letter from Ms. Z. Salikin, July 28, 1990.
50. Letter from R. Picco, July 28, 1990.
51. Letter from Mrs. L and Mr. H. Leckie, July 29, 1990.
52. Letter from Mr. F. Voylai, July 29, 1990.
53. Letter from Mr. P. Postnikoff, July 29, 1990.
54. Letter from Mrs. A. Wilson, July 30, 1990.
55. Letter from Mr. B. Meyer, July 30, 1990.
56. Letter from Mr. J. Stewart, July 30, 1990.
57. Letter from Ms. J. Ball, July 30, 1990.
58. Letter from Mr. J. Mah, July 30, 1990.
59. Letter from Mr. L. Nevakshonoff, July 30, 1990.
60. Letter from Mr A. Blessin, July 31, 1990.
61. Letter from Mr. A. Fasthuber, July 31, 1990.
62. Letter from Mr. Mr. Carey, July 31, 1990.

63. Letter from C. Willners, July 31, 1990.
64. Letter from EMCO Engineering, July 31, 1990.
65. Letter from F. Woodhouse, July 31, 1990.
66. Letter from F. Zak, July 31, 1990.
67. Letter from G. Maloney, July 31, 1990.
68. Letter from Mrs. A. Kubas, July 31, 1990.
69. Letter from Mrs. M. Feeney, July 31, 1990.
70. Letter from Mr. A. Costelli, July 31, 1990.
71. Letter from Mr. D. Green, July 31, 1990.
72. Letter from Mr. D. Martini, July 31, 1990.
73. Letter from Mr. D. Musrell, July 31, 1990.
74. Letter from Mr. D. Wallace, July 31, 1990.
75. Letter from Mr. G. Garay, July 31, 1990.
76. Letter from Mr. G. Watt, July 31, 1990.
77. Letter from Mr. G. Zeberoff, July 31, 1990.
78. Letter from Mr. J. Blair, July 31, 1990.
79. Letter from Mr. J. Holmberg, July 31, 1990.
80. Letter from Mr. J. Hughes, July 31, 1990.
81. Letter from Mr. J. Kubas, July 31, 1990.
82. Letter from Mr. J. Pilla, July 31, 1990.
83. Letter from Mr. K. Blackman, July 31, 1990.
84. Letter from Mr. K. Brownlie, July 31, 1990.
85. Letter from Mr. L. Carr, July 31, 1990.
86. Letter from Mr. L. Howell, July 31, 1990.
87. Letter from Mr. L. Sutton, July 31, 1990.
88. Letter from Mr. P. Soukochoff, July 31, 1990.
89. Letter from Mr. P. Brittany, July 31, 1990.
90. Letter from Mr. P. Clark, July 31, 1990.
91. Letter from Mr. P. Paul, July 31, 1990.
92. Letter from Mr. R. Lesy, July 31, 1990.
93. Letter from Mr. R. Lundquist, July 31, 1990.
94. Letter from Mr. T. Horuff, July 31, 1990.
95. Letter from Mr. T. Wallace, July 31, 1990.
96. Letter from Ms. C. Scorgie, July 31, 1990.
97. Letter from Ms. D. MacLeod, July 31, 1990.
98. Letter from Ms. E. Reibin, July 31, 1990.
99. Letter from Ms. J. Caron, July 31, 1990.
100. Letter from Ms. J. Konkin, July 31, 1990.
101. Letter from Ms. M. Corneird, July 31, 1990.
102. Letter from Ms. M. Gemmill, July 31, 1990.
103. Letter from Ms. N. Soobotin, July 31, 1990.
104. Letter from Ms. S. Fraser, July 31, 1990.
105. Letter from Ms. S. Zundig, July 31, 1990.
106. Letter from P. Sennhavong, July 31, 1990.
107. Letter from R. Switzer, July 31, 1990.
108. Letter from the Jollimore family, July 31, 1990.
109. Letter Ms. K. Rysen, July 31, 1990.
110. Copy of Letter by L. Ruljancich to D. McDonald, B.C. Ministry of Environment, August, 1990.
111. Letter from Mr. A. Lardose, Jr., August 1, 1990.
112. Letter from Mr. J. Helmkay, August 1, 1990.
113. Letter from Mr. J. Pachico, August 1, 1990.
114. Letter from Mr. J. Silva, August 1, 1990.
115. Letter from Mr. J. Travassos, August 1, 1990.
116. Letter from Ms. L. Gjennestad, August 1, 1990.
117. Letter from B. Campbell, August 2, 1990.
118. Letter to Nelson Daily News from David Lewis, August 2, 1990.
119. Letter from S. Hammond Re: Concerns About Composition/Biases of the Panel, August 3, 1990.
120. Letter from D. McDowell, August 13, 1990.
121. Letter from M. Hamilton, August 13, 1990.
122. Letter from CCCM, August 16, 1990.
123. Letter to Panel from Slocan Valley Watershed Alliance, August 16, 1990.
124. Letter from Celgar Modernization Advisory Group, August 17, 1990.
125. Letter to Panel from Celgar Modernization Advisory Group, August 17, 1990.
126. Letter from C. Him, August 20, 1990.
127. Letter from K. McGee Re: Public Hearing Process, August 20, 1990.
128. Letter from A. Bung, August 24, 1990.
129. Letter from H. Susut, August 24, 1990.
130. Letter from M. Nazaroff, August, 25, 1990.
131. Letter from B. Bebelman, August 27, 1990.
132. Letter from Slocan Valley Watershed Alliance, August 29, 1990.
133. Letter from J. Horswill, August 30, 1990.
134. Letter from M. Molnar, August 31, 1990.
135. Submission by Mr. L. Wilson, September 1990.
136. Submission by Ms. B. Horswill, September, 1990.
137. Submission by Ms. D. Carter, September 1990.
138. Submission by Ms. M. Johnstone, September, 1990.
139. Copy of Letter by Mr. B. James to B.C. Report Re: Celgar Expansion, September 10, 1990.
140. Attachment to Mr. C. Him Letter Re: Feb. 1988 Seminar on Black Liquor Combustion, A. Ahlstrom Corp., September 3, 1990.
141. Attachment to Mr. C. Him Letter Re: Pulping Effluents in the Aquatic Environment, 1989, September 3, 1990.
142. Letter from A. McKinnon, September 3, 1990.
143. Letter from Mr. C. Him Re: Questions for Air Quality Consultants, September 3, 1990.
144. Letter from Ms. L. Schindel, September 4, 1990.
145. Letter from G. Brady, September 5, 1990.
146. Letter from M. Gagnier, September 5, 1990.
147. Letter from R. Vandergaag, September 5, 1990.
148. Letter from W. Nitz, September 5, 1990.
149. Letter from B. Turcotte, September 6, 1990.
150. Letter from D. Martini, September 6, 1990.
151. Letter from J. Vandergaag, September 6, 1990.
152. Letter from J. Vlakovich, September 6, 1990.
153. Letter from R. Varaleau, September 6, 1990.
154. Submission by Mayor B. Trewhella, Village of Warfield, September 6, 1990.
155. Letter from D. Brandvold, September 7, 1990.
156. Letter from J. De Witt, September 7, 1990.
157. Letter from J. Vandergaag, September 7, 1990.
158. Letter from Pulp, Paper and Woodworkers Union Local #1, September 7, 1990.
159. Letter from R. LeRose, September 7, 1990.
160. Letter from S. Tucker, September 7, 1990.
161. Submission by Ald. P. Peterson, Village of New Denver, September 7, 1990.
162. Letter from Bryan's Transfer Ltd., September 8, 1990.
163. Various Attachments Re: Health Impacts of Dioxins, September 8, 1990.
164. Letter from H. Horner, September 9, 1990.
165. Detailed Minutes, Celgar Modernization Advisory Group, September 10, 1990.
166. Letter from B. Blaney, September 10, 1990.
167. Letter from G. Lakes, September 10, 1990.
168. Letter from Mr. K. McGee Re: Public Hearing Registration, September 10, 1990.
169. Letter from Ms. A. Sherrod, Valhalla Society, September 10, 1990.
170. Letter from Ms. S. Hammond, Slocan Valley Watershed Alliance Re: Concerns About CERP Consultants, September 11, 1990.

171. Letter from A. and C. Fry, September 12, 1990.
172. Letter from B. Chiriw, September 12, 1990.
173. Letter from C. McKinnon, September 12, 1990.
174. Letter from Ms. E. Goodell, September 12, 1990.
175. Letter from G. LeLore, September 12, 1990.
176. Letter from L. Pettijohn, September 12, 1990.
177. Letter from P. Walker, September 12, 1990.
178. Copy of Letter to A. Donnelly of Major Projects Review Process from by E. Goodell, September 13, 1990.
179. Letter from A. Papp, September 13, 1990.
180. Letter from Mr. D. Charters, September 13, 1990.
181. Letter from I. Conroy, September 13, 1990.
182. Letter from L. Haskins, September 13, 1990.
183. Letter from P. Phipps, September 13, 1990.
184. Letter from Mr. C. Pryce, September 14, 1990.
185. Letter from B. Wadey, September 14, 1990.
186. Letter from Castlegar & District Recreation Department, September 14, 1990.
187. Letter from D. Holis, September 14, 1990.
188. Letter from M. Wood, September 14, 1990.
189. Letter from S. Saerhin, September 14, 1990.
190. Letter from the Zdebiak Family, September 14, 1990.
191. Letter from Mr. I Nicholson, September 15, 1990.
192. Letter from Mrs. N. MacDonald, September 15, 1990.
193. Letter from Mr. G. MacDonald, September 15, 1990.
194. Letter from Mr. C. and Mrs. S. McLachlen, September 15, 1990.
195. Letter from Mr. J. Mansbridge.
196. Submission by Mrs. D. Bagg, September 17, 1990.
197. Submission by Mr. R. Belton, September 17, 1990.
198. Letter by Mr. G. Copeland, Valhalla Society, September 17, 1990 (with Attachment).
199. Letter from Ms. M. and Mr. M. Gauthier, September 17, 1990.
200. Letter from Ms. M. and Mr. J. Kennedy, September 17, 1990.
201. Letter from Ms. D. Kereiff, September 17, 1990.
202. Submission by Pope & Talbot Ltd., September 17, 1990.
203. Letter by P. Bennett, Shoreline Transport Ltd., Sept. 18, 1990.
204. Letter by Mr. J. Easton, September 18, 1990.
205. Letter by Mr. G. Exner, September 18, 1990.
206. Letter by Mr. K. Johnson, September 18, 1990.
207. Letter by Mr. S. Morin, Kokanee Equipment, September 18, 1990.
208. Letter by Dr. N. Thyer, September 18, 1990.
209. Letter from Mr. P. Verogin, September 18, 1990.
210. Letter from J. Ahle, September 19, 1990.
211. Letter from Mr. C. Booth, September 19, 1990.
212. Letter from Mr. E. Deptuck, September 19, 1990.
213. Letter from Mr. L. Levuc, September 19, 1990.
214. Letter from Mr. J. Clove, September 19, 1990.
215. Letter by Mr. D. Doman, September 19, 1990.
216. Letter from Ms. I. Doman, September 19, 1990.
217. Letter from Mr. M. Hatlen, September 19, 1990.
218. Letter from Mr. V. Hendrickson, September 19, 1990.
219. Letter from Ms. M. King, September 19, 1990.
220. Letter by M. Rush, September 19, 1990.
221. Letter from Ms. C. MacLean, September 19, 1990.
222. Letter from Ms. M. MacLean, September 19, 1990.
223. Letter from Mr. R. MacLean, September 19, 1990.
224. Letter from Mr. R. McLean, West Arm Trucking, September 19, 1990.
225. Letter by Mr. B. Miller, September 19, 1990.
226. Letter from L. Myhra, Castlegar Savings Credit Union, September 19, 1990.
227. Letter from Mr. S. Roberton, September 19, 1990.
228. Letter from Mr. R. Stephenson, September 19, 1990.
229. Submission by Ms. A. West, September 19, 1990.
230. Submission by Mr. F. Jack, September 19, 1990.
231. Submission by Mr. M. Collins, September 19, 1990.
232. Submission by Mr. R. Hawse, September 19, 1990.
233. Letter from Mr. F. Castle, September 19, 1990.
234. Letter from Mr. D. Smart, September 19, 1990.
235. Letter from Mr. R. Browell, September 19, 1990.
236. Letter from Mr. D. Stephenson, September 19, 1990.
237. Letter from Mr. D. Wallace, September 19, 1990.
238. Copy of Letter by Ms. S. Hammond, Kootenay Coalition for an EARP, to Mr. K. McGee, September 20, 1990.
239. Letter from P. Shames, September 20, 1990.
240. Submission by Mr. A. Roberts, McCrae Creek Transport, September 20, 1990.
241. Submission by Ms. G. Miner, September 20, 1990.
242. Letter from Ms. D. Bagg, September 21, 1990.
243. Submission by Mr. B. Dean, September 21, 1990
244. Submission by Mr. R. Grycan, Finning Ltd., September 21, 1990.
245. Letter from Mr. T. Isfeld, September 21, 1990.
246. Submission by Ms. D. Miner, September 21, 1990.
247. Submission by Mr. R. McKnight, September 22, 1990.
248. Letter by Mrs. D. McDowell, September 22, 1990.
249. Letter from W. Bastick, September 23, 1990.
250. Letter from C. Him, PPWC, Re: Murphy Dam Study Requirement, September 23, 1990.
251. Letter by W. Smith, September 24, 1990.
252 Letter by D. Logan, September 24, 1990.
253. Copy of Letter from Ms. B. Dendys, W. Kootenay School Trustees Assoc., to Hon D. Lewis, Minister of Transport, September 24, 1990.
254. Submission by Mr. J. Dorion, Evans Forest Products Ltd., September 24, 1990.
255. Letter by Dr. C. DeMarco, September 25, 1990 (with Attachments).
256. Submission by Ms. E. Faulks, September 25, 1990 (with Attachments).
257. Letter from Mr. G. Doeksen, September 24, 1990.
258. Submission by Ms. E. Goodell, September 25, 1990.
259. Addendum to Submission by Mr. F. Marsh, September 26, 1990.
260. Letter from Mr. J. Scott, September 25, 1990.
261. Letter from K. McGee Re: Technical Hearings Schedule, September 26, 1990.
262. Addendum to Submission by Mr. M. Adams, September 27, 1990.
263. Letter from Mayor A. Moore (with Attachment of News Release from Dr. N. Ames Re: Cancer, September 27, 1990).
264. Letter from Ms. A. Hillier, West Coast Environmental Law Association, Including Community Hearing Submission, September 27, 1990.
265. Letter from Mr. E. Kytonen, September 27, 1990.
266. Letter from Mr. S. Miros.
267. Letter from Mr. R. Willans, Kootenay Mountaineering Club, September 27, 1990 (Including Technical Hearing Submission).
268. Letter from K. McGee Re: Written Submission on Behalf of the Kootenay Coalition for an EARP, September 28, 1990.
269. Copy of Letter to Premier Vander Zalm by K. Delan, September 30, 1990.
270. Letter from Dr N. Thyer, Including Abstract of Technical Hearing Presentation, October 1, 1990.

271. Letter from Mrs L. and Mr. F. Ruljancich, Including Abstract of Technical Hearing Presentation, October 2, 1990.

272. Letter from Ms. S. Hammond, Including Abstract of Technical Hearing Presentation, October 2, 1990.

273. Letter from J. Meade, Boundary Transportation, October 2, 1990.

274. Letter from Mr. R. Lerch, Slocan Valley Watershed Alliance, October 4, 1990 (Including Abstract of Technical Hearing Presentation).

275. Letter from Ms. A. Price, October 4, 1990.

276. Letter from Mr. C. Him, PPWC, Including Technical Hearing Submission - Process, October 4, 1990.

277. Letter from Dr. D. Schindler, October 5, 1990.

278. Letter from Mr. C. Him, PPWC, Including Technical Hearing Submission - Water Quality, October 5, 1990.

279. Letter from P. Weingard, October 5, 1990.

280. Barbara Tandory, "A Pulp Standoff in the Kootenays," B.C. Business, October 8, 1990.

281. Letter from Mr. C. Him, PPWC, Including Technical Hearing Submission - Air Quality, October 8, 1990.

282. Letter from Ms. B. Taves, October 9, 1990.

283. Copy of Letter from Valhalla Society to Celgar Pulp Company, October 10, 1990.

284. Letter from Mr. M. Bronaugh, Including Abstract of Technical Hearing Presentation, October 10, 1990.

285. Letter from Mr. S. McKay, October 11, 1990.

286. Letter from Mr. S. Leyland, October 12, 1990.

287. Letter from Ms. P. Ball, Chariperson, Mt. Sentinel Parent Advisory Committee, October 12, 1990.

288. Letter from S. Benedict, October 15,

289. Letter from Mr. M. McMullen, PPWC Re: Fibre Supply, October 16, 1990.

290. Letter from Mr. R. Rossman, October 16, 1990.

291. Letter from Mr. C. Him, PPWC, October 17, 1990.

292. Letter from B. Manchester, October 18, 1990.

293. Letter from Dr. N. Thyer, October 20, 1990.

294. Letter from Mr. B. Reiter, PPWC, October 22, 1990.

295. Letter from J. Meade Re: Financial Sheets, October 24, 1990.

296. Letter from Ms. A. Sherrod, Vahalla Society, October 25, 1990.

297. Letter from P. Weingard, With Attached Article from the Nelson Daily News, October 25, 1990.

298. Letter from J. Meade Re: Potential Viability of Low Density Rail in the Kootenay-Boundary Area, October 26, 1990.

299. Letter from Mr. C. Him, PPWC, October 27, 1990.

300. Letter by A. Walters, October 27, 1990.

301. Letter from Mr. M. Bronaugh, October 27, 1990.

302. Letter from Mr. R. Lahner, B.C. Ambulance Services, October 27, 1990.

303. Dr. M. O'Brien - Answers to Questions Posed by Celgar at Technical Hearing, October 28, 1990.

304. Dr. N. Thyer, Proposal for Air Quality Monitoring, November 5, 1990.

305. Letter from Mr. G. Wise, July 23, 1990.

306. Letter from G. Carlson, July 27, 1990.

307. Letter from J. Hughes, August 1, 1990.

308. Letter from K. Hadden, August 13, 1990.

309. Letter from Pulp, Paper and Woodworkers Union Canada with Attachment: Potlach Corp. Effluent Toxicity Evaluation, November 8, 1990.

310. Press Release by Valhalla Society, Valhalla Society Denies Support of Mill Expansion, November 8, 1990.

311. Letter from Ms. L. Ruljancich, August 22, 1990.

312. Letter from Mr. B. Manchester, August 30, 1990.

313. Letter from Ms. S. Benedict, August 30, 1990.

314. Letter from Mr. F. Ross, September 10, 1990.

315. Letter from Mr. C. Him, September 14, 1990.

316. Letter from Mrs. H. Pottle, Mrs. G. Baines, Ms. M. Baulne, Ms. C. Zuidig and Ms. D. Wuiechar, September 17, 1990.

317. Letter from Mr. L. Kristiansen, M.P., September 18, 1990.

318. Letter from Ms. J. Craig, September 18, 1990.

319. Letter from Dr. M. O'Brien, Including Abstract of Technical Hearing Presentation, October 10, 1990.

320. Submission by B. Burgoon, October 15, 1990.

B. Government Correspondence and Reports

1. Copy of News Release from Minister of Environment - Non-Compliance Pollution List, July 13, 1990.
2. Reply to Request for Information by Mr. R. W. Dryden, B.C. Ministry of Environment, July 26, 1990.
3. Copy of Environment Canada Memo from Water Quality Assessment Officer to B. Kelso, August 1, 1990.
4. Copy of Memo from Mr. B. Raymond (State of Washington) to Ms. B. McNaughton, Environment Canada, August 2, 1990.
5. Copy of Environment Canada Memo from Mr. B. Kelso to Ms. B. McNaughton, August 3, 1990.
6. Memo from Mr. A. Johnson et al, State of Washington Dept. of Ecology, to Mr. C. Nuechterlein Re: Lake Roosevelt Dioxin/ Furan Survey, August 8, 1990.
7. Celgar Expansion Review Panel - Further Request for Information to Celgar Pulp Company, August 14, 1990.
8. CERP - Further Request for Information to Celgar Pulp Company, August 14, 1990.
9. Celgar Expansion Review Panel - Request for Information to the Governments of Canada and B.C., August 22, 1990.
10. Copy of Environment Canada Memo from Mr. D. Poon to Mr. C. Di Cenzo re: EPA Air Quality Standards, August 22, 1990.
11. Letter from the B.C. Ministry of Energy, Mines and Petroleum Resources, August 23, 1990.
12. Letter from the B.C. Ministry of Energy, Mines and Petroleum Resources Re: comments on Stage II Reports, August 27, 1990.
13. Letter from Environment Canada, Water Quality Branch, August 28, 1990.
14. Letter from Environment Canada, Water Quality Branch, Re: Celgar Expansion Review Panel Request for Information, August 28, 1990.
15. State of Washington - Province of B.C. Water Quality Meeting, August 30, 1990.
16. B.C. Ministry of Environment, Columbia River Integrated Monitoring Program (Prepared by Sigma Engineering Ltd.), September, 1990.
17. Letter from Mr. P. Toft Re: Health and Welfare Canada Review of Stage II Report, September 5, 1990.
18. Letter from Mr. D. Dryden and Mr. F. Blasetti Re: Request for Information from the CERP September 7, 1990.
19. National Transportation Agency of Canada, Decision Re: CPR Proposed Boundary Subdivision Rail Line Abandonment (abridged title), September 10, 1990.
20. Letter from Mr. P. Halkett, B.C. Ministry of Forests Re: Pulpwood Agreement No. 9, September 10, 1990.
21. Letter from Mr. D. Harasym, Regional District of Central Kootenay.
22. Letter from Ms. B. McNaughton, Health and Welfare Canada Re: Celgar Bleached Kraft Mill Modernization Request for Information, Sept. 18, 1990.
23. Letter from Colville Confederated Tribes Re: Stage II Reports, September 24, 1990.
24. Letter from Mr. J. Philion Re: Request to B.C. Ministry of Health, September 24, 1990.
25. Consolidated Provincial Government Agency Comments on Stage II Report, September 27, 1990.
26. Letter from Mr. D. Dryden and Mr. F. Blasetti Re: Consolidated B.C. Government Response, September 27, 1990.
27. Letter from Mr. D. Dryden, Major Project Review Process, October 4, 1990.
28. Letter from Mr. T. Wilson, U.S. Environmental Protection Agency, October 4, 1990.
29. Letter from Mr. J. Krull, State of Washington Department of Ecology, October 4, 1990.
30. Letter from Mr. P. Chamut, Deptartment of Fisheries and Oceans, October 11, 1990.
31. Letter from Mr. R. Crozier, B.C. Ministry of Environment, Re: Columbia River Integrated Monitoring Program, October 12, 1990.
32. Letter from Mr. M. Nassichuk, Fisheries and Oceans Canada, October 16, 1990.
33. Copy of Letter to Celgar from B.C. Ministry of Energy Mines and Petroleum Resources Re: Energy Project Certificate Application, October 17, 1990.
34. Corrections for Table 2, p. 14 of the B.C. Ministry of Transportation and Highway's Technical Hearing Submission, October 18, 1990.
35. Letter from Mr. D. Harasym, Regional District of Central Kootenay, Including Resident and Non-Resident Sruveys for Northern Area 'H', October 20, 1990.
36. Health Protection Branch Issues on Dioxins and Furans, October 23, 1990.
37. Letter from D. Kirkpatrick, Health & Welfare Canada, October 23, 1990.
38. V. Holm, Ministry of Forests Re: Analysis Framework for Integrated Resource Management, Oct. 24, 1990.
39. Letter from Dr. N. Ames, Central Kootenay Health Unit, October 3, 1990.
40. Replacement Pages/Supplements for MOE Submission Re: Vegetation Impacts, November 7, 1990.
41. Department of Fisheries and Oceans and the Department of the Environment, Addendum on the Celgar Pulp Mill Modernization Proposal, November, 1990.
42. B.C. Ministry of Environment, 1977, Proposed Udpate of Pollution Control Objectives for the Forest Products Industry.
43. B.C. Ministry of Environment, 1986, "Castlegar Air Quality."
44. B.C. Ministry of Environment, 1986, "Trail Air Quality."
45. B.C. Ministry of Environment, 1989, Pollution Control Objectives for the Forest Industry.
46. Colville Indian Band, Investigation of the Nature and Extent of the Floating and Submerged Algal Mat (Cladophora/ Diatom) "Bloom" Phenenomena in Franklin D. Roosevelt Lake, prepared by E. Broch and J. Loescher, Washington State University, October, 1988.
47. Dioxin/Furan Survey of Lake Roosevelt.
48. Health and Welfare Canada, 1990, "Health Risk Determination: The Challenge of Health Protection."
49. B.C. Ministry of Transportation and Highways , Submission to the NTA of Canada In the Matter of an Application by CPR Ltd...to Abandon a Portion of the CP Rail Boundary Subdivision between Robson West and Midway in the Province of B.C., May 18, 1990.
50. Servici, J., et. al., "Effects of Bio-Treated Bleached Kraft Mill Effluent on Fingerling Chinook Salmon," presented at the Canadian Symposium on Water Pollution Research, Canada Centre for Inland Waters, Burlington Ontario, February 15, 1990 (Updated October 15, 1990).
51. Steering Committee of the Major Project Review Process, July, 1990, Review of Prospectus for Celgar Pulp Mill Expansion.
52. Correspondence file from government regarding the Stage I Report.
53. Two volumes of letters from the public regarding the Stage I Report, also listed as Community Hearing Document No. 25.
54. Environment Canada and Department of National Health & Welfare, Canadian Environmental Protection Act - Priority Substances List Assessment Report No. 1 - Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans, 1990.
55. Letter from Dr. V. Armstrong, Health and Welfare Canada, October 11, 1990.
56. Letter from Mr. D. Dryden, B.C. Ministry of Environment, October 16, 1990.
57. Letter from Mr. K. Rockerbie, B.C. Ministry of Transportation and Highways, October 21, 1990.

58. Regional District of Central Kootenay, Slocan Valley Planning Program Tourism Analysis, Technical Report, October 1981.

C. OTHER MATERIALS

1. B. Dalton, Analysis of Forest Issues.
2. Mr. G. Doeksen, April 10, 1989 Brief to the Kootenay Regional Transportation Task Force.
3. B.C. Hydro, Lower Columbia River Pilot Boating and Sport Fishing Survey (Prepared by The DPA Group Inc.), March, 1990.
4. Decision by the NTA of Canada Re: CPR's Line Abandonment in the Boundary Subdivision.
5. D.W. Schindler - Possible Effects of the Proposed Alberta Pacific Mill on the Athabasca River.
6. Investigation of the...Floating and Submerged Algal Mat "Bloom" Phenomena in Roosevelt Lake.
7. Dr. J. Sprague - Environmentally Desirable Approaches for Regulating Effluents from Pulp Mills, presented at 3rd IAWPRC Symposium on Forest Industry Wastewaters, Tempere, Finland, June 1990.
8. Dr. J.P. Kimmins, "Clearcutting: Reponsible Forest Management or Environmentally Destructive Forest Exploitation?"
9. Minutes of Celgar Modernization Advisory Group, September 10, 1990.
10. Pleasure Craft Usage of H.L. Keenleyside Lock, 1983 - 1989, November, 1989 (No Author)
11. Slocan Valley Development Guidelines, Prov. of B.C./Regional District of Central Kootenay.
12. Mr. B. Reiter, PPWC, "The Other Side of the Canadian Pulp & Paper Industry: The Urgent Need for Environmental Regulatory Reform."
13. Unaddressed/Undated Letter from Southern Interior Charters.
14. Univ. of Illinois at Urbana-Champaign, "Nationwide Experience with New Small Railroads formed to Take Over Abandoned Lines, 1971-84."
15. B.C. Hydro, Lower Columbia Development - Fisheries Study Plan, March 1990 (Draft).
16. Dr. D. McCLeay and Associates, Ltd., 1987, "Aquatic Toxicity of Pulp and Paper Mill Effluent, A Review."
17. Fleming, B. I., et. al., February, 1990, "A Discussion of the AOX Paramenter as a Tool for Environmental Protection."

II. Documents Prepared For Or On Behalf of CERP

1. Mr. R. Partington, Preliminary Analysis of Stage II Reports, July 24, 1990.
2. Dr. F. Murray, Preliminary Review of Stage II Reports, July 25, 1990.
3. McLeay Associates Ltd., Review of Stage II Reports.
4. Mr. P. Roer, Preliminary Review of Stage II Reports, August 3, 1990.
5. Mr. R. Kistritz, Preliminary Review of Stage II Reports, August 3, 1990.
6. Dr. K. Hall, Preliminary Review of the Stage II Reports, August 4, 1990.
7. CERP, Public Hearing Procedures, August 20, 1990.
8. Mr. P. Roer, Summary of August 29, 1990 Meeting with Advisory Committee of the City of Castlegar, September 11, 1990.
9. Mr. J. McWilliams, Report on Hog Fuel, September, 1990.
10. Dr. F. Murray, Summary of August 30, 1990 Meeting with Advisory Committee of the City of Castlegar, September 1, 1990.
11. Dr. D. McCleay, Report of August 30, 1990 Meeting with Environmental Groups, September 5, 1990.
12. Dr. K. Hall, Minutes during Question and Answer Period of the Castlegar Meeting with Local Environmental Organizations, September 8, 1990.
13. Dr. F. Murray, Summary of September 9, 1990 Meeting with Environmental Groups, September 10, 1990.
14. Mr. R. Partington, Summary of August 29, 1990 Meeting with Advisory Committee of the City of Castlegar, September 11, 1990.
15. Mr. J. McWilliams, Report of August 30, 1990 Meeting with Environmental Groups, September 12, 1990.
16. Mr. J. McWilliams, Report of September 8, 1990 Meeting with Environmental Groups, September 12, 1990.
17. Mr. R. Partington, Summary of September 8, 1990 Meeting with the Public, September 26, 1990.
18. Dr. D. McCleay, Overview of Proposed and Potential Methods for Detoxification of Effluent and Monitoring Toxicity, September 28, 1990.
19. Mr. J. McWilliams, Report of September 27, 1990 Meeting With Environmental Groups, September 28, 1990.
20. Report by Mr. R. Kistritz and Mr. A. Sobolewski on Fibre Mat Research, October 1, 1990.
21. Letter From Dr. K. Hall to Dr. M. Mealing Re: Water Quality Questions, October 29, 1990.
22. Mr. R. Partington, Additional Questions of the Stage II Report, October 29, 1990.
23. Dr. F. Murray, Review of B.C. Ministry of Environment Presentation at the Technical Hearings, November 7, 1990.
24. Mr. P. Roer, Review of B.C. Ministry of Transportation and Highways Presentation at the Technical Hearings, November, 1990.
25. Celgar Expansion Review Panel Newsletter No. 1, July, 1990.
26. Celgar Expansion Review Panel Newsletter No. 2, July 26, 1990.
27. Celgar Expansion Review Panel Newsletter No. 3, August 20, 1990.
28. Celgar Expansion Review Panel Newsletter No. 4, September, 1990.
29. Celgar Expansion Review Panel Newsletter No. 5, October, 1990.
30. Celgar Expansion Review Panel - Notice of Public Hearings.
31. Dr. D. McCleay and Associates Ltd., Comments on the Stage II Report.
32. Mr. J. McWilliams, Report on Wood Fibre for the Expanded Kraft Pulp Mill at Castlegar, B.C., August 7, 1990.
33. CERP, Notice of Request for Information from Governments of Canada and British Columbia.
34. Dr. D. McLeay, Additional Information for the CERP Re: the Use of Biological Test Methods, November , 1990.
35. Celgar Expansion Review Panel, Interim Report, December, 1990.

III. Documents and Correspondence Prepared By Or On Behalf of Celgar Pulp Company

1. Celgar Pulp Company, Bleached Kraft Mill Expansion Environmental Impact Assessment, December, 1989 (Prepared by E.V.S. Consultants Ltd. and Cirrus Consultants).
2. Celgar Pulp Company, SocioEconomic Report, January, 1990.
3. Celgar Pulp Company, Stage II Report, Volume 1, "Overview and Environmental Summary," July, 1990.
4. Celgar Pulp Company, Stage II Report, Volume 2, "Fibre Sourcing and Transportation," July, 1990.
5. Celgar Pulp Company, Stage II Report, Volume 3, "Effluent and Receiving Water Impact Assessments," July, 1990.
6. Celgar Pulp Company, Stage II Report, Volume 4, "Air Emissions and Air Quality Impact Assessments," July, 1990.
7. Celgar Pulp Company, Stage II Report, Volume 5, "Socio-Economic & Archaeological Impact Assessments," July, 1990.

8. Letter from Stikeman & Elliot and Bull, Houser & Tupper Re: Hearing Procedures, July 25, 1990.
9. Letter from EVS Consultants Re: Corrections to Stage II Water Quality Report, July 31, 1990.
10. Celgar Pulp Company, Additional Information, August, 1990.
11. Letter from CITIC Re: Concerns About Hearing Schedule, August 29, 1990.
12. Letter from Power Consolidated (China) Pulp Inc. Re: Concerns About Hearings Schedule, August 29, 1990.
13. Letter from Celgar Pulp Company Re: Response to August 14, 1990 Request For Further Information, August 31, 1990.
14. Letter from Celgar Pulp Company Re: September 10, 1990 Letter by the Valhalla Society.
15. Supplementary Submission to Technical Hearings - 1989 Interior Chip Supply Scenario, October 5, 1990.
16. Abstract and Bibliography Re: Celgar's Presentation at Technical Hearings, October 12, 1990.
17. Letter from Celgar Pulp Company Re: Supplementary Submissions to Technical Hearings, Including Copy of Technical Hearing Submission by Mr. H. Hargback, October 12, 1990.
18. Copy of letter from Celgar Pulp Company to the Ministry of EMP&R, Including Energy Project Certificant Application, October 12, 1990.
19. Report from Cirrus Consultants to Ministry of Environment Re: Ambient Air Quality, October 15, 1990.
20. Letter from Mr. P. Levelton, Peat Marwick Stevenson & Kellogg Re: Barge Loading Facilities and Chip Truck Loads, October 16, 1990.
21. EVS Consultants, Impact of Modernized Mill Discharge of Soluble Nitrogen and Phosphorus on the Columbia River, October 17 1990.
22. Information From Celgar Pulp Company Re: Accident Statistics; Impact of Emissions on Vegetation, October 17, 1990.
23. Copy of Letter from Celgar Pulp Company to the Ministry of Energy, Mines and Petroleum Resources Re: PR from Celgar Re: Section D Ancillary Application, October 22, 1990.
24. Peat Marwick Stevenson & Kellogg, Response to Information Request Re: Chemicals to be Moved by Truck, November 6, 1990.
25. Celgar Pulp Company, Response to Information Request Re: Transportation Costs, November 8, 1990.
26. Letters from Celgar Pulp Company, July 16/July 17, 1990.
27. Cirrus Consultants, Response to Questions Raised During Hearings, November 9, 1990.
28. Columbia Pacific Group, Reponse to Questions Raised During Technical Hearings, November 9, 1990.
29. Dr. B. Willis, Clarification of Health Considerations, November 9, 1990.
30. EVS Consultants, Clarification of Items Discussed During Technical Hearings, November 9, 1990.
31. H. A. Simons Ltd., Response to Information Request Re: Water Quality/ Process, November 9, 1990.
32. NovaTech Consultants Inc., Response to McLeay Report Comments About Effluent Variability, November 9, 1990.
33. Letter from Celgar Pulp Company Re: Anti-Sapstain Lumber Treatment, November 9, 1990.
34. Celgar Pulp Company, June 1990, Pulpwood Agreement Proposal.
35. Copy of Celgar Pulp Company's Energy Project Certificate Application.

IV. COMMUNITY HEARING DOCUMENTS

September 20, 1990 - Castlegar

1. List of Celgar Review Panel Speakers.
2. All Overhead Projection Sheets Used By Celgar.

2.1. Amplification of Transparency used by Mr. C.H. Gairns.

3. Appendix to Sudbury Study.
4. Woodfibre Pulp Mill Respiratory Health Survey.
5. PPWC Union Constitution 1990-91.
6. Submission by the Material Handling Department of Celgar.
7. Submission by Castlegar Chamber of Commerce - Prepared by The DPA
8. Kotturi, M. S., The Corrosion Rates of Metals Exposed to Pulp-Mill and Smelter Emissions, Ministry of Environment, January, 1980.
9. Flightcraft Documents Submitted by Mr. R. Lowe.
10. Submission by Mrs. D. Martini.
11. Submission by Mr. R. Collier.
12. Letter from Mr. I. Barber - Slocan Forest Products Ltd.
13. Editorial by the Nelson Daily News.

September 21, 1990 - Castlegar

14. Submission by Dr. N. Ames, Central Kootenay Health Unit.
15. Submission by Mr. R. Schmidt, United Steelworkers of America.
16. Submission by Dr. M. Mealing.
17. Submission by Mr. K. Offermann, IWA Local 1405 (with Attachment).
18. Submission by Mr. T. Dalton.
19. Submission by Mr. D. Lewis.
20. List of Groups and Individuals Represented by the West Coast Environmental Law Association.
21. Log Books of Mr. A. Roberts - McRae Creek Transport.
22. Submission by Mr. M. Gilfillan.
23. Celgar's Reports and Transparencies.
24. Chart and Statement - Mr. Frank Ruljancich
25. Two Volumes of Public Submissions to the Stage I Report.

September 22, 1990 - Nelson

26. Documents Referred to by Mr. G. Retterath.
27. Valhalla Society Information Bulletin Newsletter #18, Sept. 1990.
28. Slides and Transparencies - Mr. G. Copeland.
29. Reports, Materials and Studies Referred To by Ms. A. Sherrod.
30. Documents Provided by Ms. P. Bossort.

30.1. Submission by Ms. Patty Bossort.

31. Extract From Stern Magazine (Original in German, Partial Translation).

September 24, 1990 - Slocan

32. Official Petition Submitted by Winlaw Area Residents.
33. Letter from Sharon Farinha to Mr. Browne.
34. Transportation Group Highway Finance - A Literature Review; prepared by University of New Brunswick.
35. A. Kenneth, et al. A System of Methodology to Determine the Impact of Rail Line Abandonment on Damage to Roads.
36. Mr. G. Zaitsoff - Photographs of Truck Logs.
37. Study of Acid Rain Levels in Lakes by Kaslo School Children, referred to by Ms. L. Mandala.

September 25, 1990 - Silverton/Nakusp

38. Submission by Mr. R. Harley.
39. Report of Central Regional District of Central Kootenay.
40. Submission by Ms. B. McNeil.
41. Submission by Ms. S. Hammond.
42. Survey of Resident Landowners Referred to by Ms. E. Goodell.
43. Study Referred to by Mr. J. Herman.
44. Letter from West Kootenay School Trustees' Association.
45. Documents Referred to by Mr. B. Nielson and Mr. D. Herreshoff.
46. Number not used.
47. Submission by Mr. J. Heavenor, Downie Street Sawmills.
48. Documents From Ms. C. Bowman.
49. Submission by Mr. J. Meade, Boundary Transportation Partnership.
50. Notes from Chambers Trucking Limited.
51. Documents Referred to by Mr. F. Maltby.
52. Submission by Mr. W. Schmirler, Evans Forest Products.
53. Submission by Mr. D. Madlung, Westar Timber.

September 26, 1990 - Trail

54. Documents Referred to by Mr. J. Meyer.
55. Submission by Mr. R. Ross, Emco Engineering.
56. Photocopies of Photographs of Fish from the Columbia River.
57. Pictures of Tree Planting Ceremony in Castlegar, September 20, 1990.
58. Documents Referred to by Mr. Peitzche.
59. Letter from Mr. P. Blackwell.

V. TECHNICAL HEARING DOCUMENTS

October 18, 1990 - Wood Chip Supply

1. List of members that comprise the Kootenay Coalition for an EARP.
2. Overheads used by Celgar.
3. Stewart Ewing Associates Report, 1989 Interior Chip Scenario for the Province of B.C., 1990.
4. B.C. Science Council Report on Forestry Development in B.C.
5. T.M. Thompson Report - Intensive Forest Management Plan for Regional District of Central Kootenay.
6. O. R. Travers - Potential Fish Habitat Implications of the Celgar Application for Pulpwood Timber Supply in Pulpwood Agreement No. 9.
7. Written Submission by Westar Timber Ltd.
8. Abstract provided by Mrs. L. and Mr. F. Ruljancich.
9. Transparencies and charts of Mr. F. Ruljancich.
10. B.C. Forest Commission Report.
11. Abstract of Mr. S. Leyland.
12. Submission of Mr. S. Leyland.
13. Photocopies of Extracts provided by Mr. S. Leyland.
14. Qualifications of Mr. J. Juhasz and Mr. V. Holm, B.C. Ministry of Forests
15. Submission by the Ministry of Forests.
16. Ministry of Forests Study of the Southeast British Columbia Fibre Resource.
17. Two Transparencies - Potential Annual Fibre Supply from P.A. No. 9.
18. Analysis Framework for Integrated Resource Management.
19. Department of Fisheries and Oceans Canada Submission (See Submission No. 6, October 18, 1990).
20. Statement of Qualifications - Mr. J. Payne.
21. Statement of Qualifications - Mr. J. McWilliams.
22. Submission by Mr. J. McWilliams - Wood Fibre for the Expanded Kraft Pulp Mill a Castelgar, B.C.
23. Mr. J. McWilliams - Report on Hog Fuel for Celgar Expansion Review Panel.
24. Mr. J. McWilliams - Summary of Presentation and Discussion with Public Interest Groups in Trail, Sept. 27, 1990.
25. Overhead Slides Used by Mr. J. McWilliams.

October 19, 1990 - Transportation

26. Overhead Slides Used by Mr. P. Levelton.
27. Overhead Slides Used by Mr. D. Mills.
28. Overhead Slides Used by Mr. D. Hildebrand.
29. Book Containing Resumes of Experts Appearing for Celgar Pulp Company, with Addenda.
30. Submission by Dr. T. Heavor.
31. Abstract of Submission by Boundary Transportation (including Appendix).
32. Submission by Mr. J. Meade, Boundary Transportation (with Appendices).
33. Abstract of Submission by Slocan Valley Watershed Alliance.
34. Submission by Mr. B. Lerch, Slocan Valley Watershed Alliance.
35. Submission by B.C. Ministry of Transportation and Highways (with Appendices and Supplement)
36. Statement of Qualifications - Mr. P. Roer.
37. Statement of Qualifications - Mr. R. Partington.
38. Mr. P. Roer's Review of the Stage II Report.
39. Mr. R. Partington's Review of the Stage II Report.
40. Mr. P. Roer Report - Safety and Road Capacity.
41. Mr R. Partington - Summary of Meeting with Interested Persons.
42. Mr. P. Roer - Effects of Additional Truck Traffic.

October 20, 1990 - Community/Archaeological Considerations

43. Transparencies Used by Mr. D. Hildebrand, Columbia Consulting Group.
44. Submission by the City of Castlegar (with Abstract and Transparencies)
45. Submission by the Castlegar Chamber of Commerce, Economic Implications of Celgar Modernization Project for Castlegar (Prepared by DPA Group Inc.).
46. Submission by Dr. M. Mealing, Archaeological Impact Assessment Critique (with Abstract).
47. Documents Presented by Mr. F. Ruljancich.
48. Submission by Mr. R. Barkely.

October 25, 1990 - Pulp Mill Processes/Water Quality and Fisheries

49. Overheads Used by Dr. L. Galloway.
50. Submission by Mr. C. Him, Pulp, Paper and Woodworkers Union Local No. 1.
51. Submission by Mr. B. Reiter, Pulp, Paper and Woodworkers Union Local No. 1 (with Attachments).
52. Submission by Mr. G. Melnechuk, Pulp, Paper and Woodworkers Union Local No. 1.
53. Joint Submission by the Department of Fisheries and Oceans and Department of the Environment.
54. Resumes of Department of Fisheries and Oceans Representatives.
55. Submission by the B.C. Ministry of Environment (with Addendum)

55.1. Overheads Used by the B.C. Ministry of Environment.

56. Resumes of B.C. Ministry of Environment Reprentatives.

57. Transparencies used by Dr. G.A. Vigers.

58. Dr. J. Sprague's Review of the Stage II Report.

59. Dr. M. O'Brien - Resume, Abstract and List of References.

60. Submission by Dr. M. O'Brien, Kootenay Coalition for an EARP.

October 26, 1990 - Water Quality and Fisheries

61. Transparencies Used by Dr. D. Schindler.

62. Submission by Washington Department of Ecology, Proposed Effluent Limitations for Dioxin and AOX, July 1990.

63. Overhead Slides Used in the Submission by the Department of Fisheries and Oceans and the Department of the Environment (with Abstract).

64. Submission by Dr. N. Ames, B.C. Ministry of Health (with Attachments).

65. September 26, 1990 Press Release from the B.C. Ministry of Health.

66. Transparencies Used by Mr. P. Whitehead.

67. Publications Referred to by Dr. L. Lockhart, Swedish Environmental Protection Board Report No. 3558, "Biological Effects of Bleached Pulp Mill Effluent," and the Journal of Water Science and Technology, "Forest Industry, Wastewaters, Environmental Effects," Vol. 20, No. 2, with various other attachments.

68. Ministry of Environment, Columbia River Integrated Environmental Monitoring Program, September, 1990.

69. Transparencies Used by Mr. R. Crozier.

70. B.C. Government Response to the Stage II Report.

71. Submission by Mr. M. Bronaugh (with Attachments).

October 27, 1990 - Water Quality and Fisheries

72. Transparencies Used by Mr. P. Calder, B.C. Hydro.

73. Transparencies Used by Mr. G. Kenyon, Cominco.

74. Submission by Dr. C. DeMarco - Summary.

75. Submission by Dr. C. DeMarco.

76. Submission by Dr. M. Mealing

77. Mr. R. Crozier - Responses to Requests for Further Information.

78. Number not used.

79. Submission by Pulp, Paper and Woodworkers Union, Local No. 1.

80. Submission by Mr. B. Reiter, Pulp, Paper and Woodworkers Union Local No. 1.

81. Material Referred to by Mr. G. Melnechuk, Pulp, Paper and Woodworkers Local No. 1.

82. Statement of Qualifications - Dr. K. Hall.

83. Dr. K. Hall's Comments on the Stage II Report.

84. Dr. K. Hall - Summary of Meeting with Local Environmental Groups, September, 1990.

85. Transparencies Used by Dr. K. Hall.

85.1. References Provided by Dr. R. Peterman.

85.2. Transparency and Report Submitted by Mr. H. Hargback, AF-Industrins Processkonsult AB.

November 1, 1990 - Air Quality

86. Abstract of Submission by Mr. H. Hammond, Kootenay Coalition for an EARP.

86.1. Qualifications of Michael Gordon and Donald McLeay.

87. Submission by Mr. H. Hammond, Kootenay Coalition.

87.1. McLeay Associates Comments on the Stage II Report.

88. Resume of Mr. H. Hammond

88.1. Report of McLeay Associates on Detoxification and Monitoring of Toxicity.

89. Overheads Used by Celgar Pulp Company.

89.1. Replacement Overhead - Estimated Deposition of Sulphur and Nitrate.

90. Letter from Cirrus Consultants to the B.C. Ministry of Environment.

91. Report Submitted by Dr. S. Linzon.

92. Report Referred to by Dr. Ruby, McMahon, T. H., et al., "Long Distance Air Pollution Transportation Model in Washout and Dry Deposition Components," Atmospheric Environment, Vol. 10, pp. 751-61, 1976.

93. Submission by Mr. C. Him, Pulp, Paper and Woodworkers Union Local No. 1

94. Submission by Mr. G. Melnechuk, Pulp, Paper and Woodworkers Union Local No. 1

95. Submission by Mr. F. Hinton, Pulp, Paper and Woodworkers Union Canada.

96. Outline of Submission by Mr. C. Him.

97. Kootenay Air and Water Quality Study.

98. Pulp and Paper Journal, September 1990.

99. Submission by Mr. R. Lowe.

99.1. Additional Information Submitted by Mr. R. Lowe - 1988, 1989 Castlegar Hospital Emission Monitoring Program.

100. Overheads Used by the Department of the Environment.

101. Submission by Dr. N. Thyer.

102. Further Documents from the B.C. Ministry of Environment.

103. Statement of Qualifications - Dr. F. Murray

104. Dr. F. Murray's Review of the Stage II Report.

105. Dr. F. Murray - Summary of Meetings with Interested Persons.

Other Technical Hearing Submissions

1. Supplementary Submission to Technical Hearings - Process Design Review Documents.
2. Supplementary Submissions to Technical Hearings.
3. List of the Department of Fisheries and Oceans and Department of Environment Staff attending the Technical Hearings.
4. Joint Submission by Ms. S. Knoerr, Mr. D. Healing, Mr. L. Ball and Mr. G. Brown, November 1, 1990.
5. Submission by The Valhalla Society - Material on the Corporate Ownership of the Celgar Pulp Company.
6. Submission by Mr. A. Walters, November 1, 1990.
7. Addendum to Submission by Mr. Calder, Lower Columbia Boating and Sport Fishing Survey (March 1990), November 2, 1990.

VI. FINAL SUBMISSIONS

1. Letter from J. Meade Re: Capital Cost Allowance Applied, November 5, 1990.
2. Mr. C. Him and Mr. F. Henton, PPWC, Final Sumission to CERP, November 6, 1990.
3. Pulp, Paper and Woodworkers Union Local # 1, Final Submission to CERP, November 7, 1990.
4. Letter from Mrs. L. & Mr. F. Ruljancich, Closing Statements, November 7, 1990.
5. Kootenay Coalition for an EARP - Final Submission to CERP, November 9, 1990.
6. Valhalla Society, Final Submission to Stage II Review Process, November 9, 1990.
7. Ms. A. Sherrod, Valhalla Society, Replacement Pages for Valhalla Society Submission, November 14, 1990.
8. Celgar Pulp Company, Closing Statement, November 9, 1990.

APPENDIX 5: PANEL MEMBERS

MRS. JILL BODKIN
(CHAIRPERSON)

Mrs. Bodkin is the Director of Financial Services and a partner with Ernst & Young chartered accountants and management consultants in Vancouver. She received a B.A. from the University of Alberta in 1963 and completed M.P.A. studies at Syracuse University in 1979. She was the founding Chairman and former C.E.O. of the British Columbia Securities Commission and has served as Deputy Minister of Consumer and Corporate Affairs for British Columbia from 1981 to 1986. She was a member of the Secretariat to the federal Cabinet Committee on Economic Development and was later appointed to the Sectoral Advisory Group on Trade in Financial Services for the GATT negotiations. She is a member of the British Columbia Science Council Fiscal Committee, a Director of the Vancouver Board of Trade, and on the Research Committee of the Institute for Research in Public Policy.

DR. THOMAS G. NORTHCOTE

Dr. Northcote is a Professor in the Department of Forest Sciences, Department of Zoology and the Westwater Research Centre at the University of British Columbia. Dr. Northcote is a specialist in the impact of human activity on inland aquatic ecosystems. He is a former Director of the Canadian Society of Wildlife and Fishery Biologists, a Director of the Rawson Academy, Director of the Institute of High Andean Waters at the National University of the Altiplano, Peru, and a longtime member of the Board of Governors of the Vancouver Public Aquarium. Dr. Northcote twice has served as an Associate Editor for the American Fisheries Society and currently is an Associate Editor of the Nordic Journal of Freshwater Research and of the Polish Archives for Hydrobiology.

DR. PAUL R. THOMAS

Dr. Thomas is President of Paul R. Thomas Pulp Consulting, which provides technical consulting services to pulp and paper companies. He received a B.Sc. from the University of Durham, England in 1959 and a Ph.D. from the same institution three years later. Dr. Thomas has more than 26 years of technical experience in the forest products industry, including 15 years as co-founding partner of Econotech Services Limited, a pulp and paper research and development centre. He has research and field experience in both process and environmental aspects of the industry. Dr. Thomas is a member of the Canadian Pulp and Paper Association, the Technical Association of the Pulp and Paper Industry, and the Chemical Institute of Canada.

ACKNOWLEDGEMENTS

The Panel would like to acknowledge the valuable contribution of the following people:

Executive Secretary:
Alan Ferguson

Counsel:
Frank Borowicz

Staff:
Gary Reith
Betsy Goolief
Christina Chung
Denise Stefan

Court Reporters:
(Total Reporting Service)
Alana Skuce
Laurie Pickering
Melanie McEachern
Diane McFie
Carol Jackson
Jackie Wilson
Marilyn Jamernik

Consultants to the Panel included:

Dr. Ken Hall
Water Quality

Mr. Ron Kistritz
Aquatic Ecology

Dr. Don McLeay
Aquatic Toxicology

Mr. Jim McWilliams
Forestry

Dr. Frank Murray
Air Quality

Mr. Bob Partington
Transportation

Mr. Paul Roer
Transportation

The report layout and printing was completed by James Martin of Peregrine Press, White Rock, British Columbia.

Maps and Graphics were prepared by Sharon Gramchuk of XY3 Graphics, Vancouver, British Columbia.

Photo Credits:

Castlegar News
Gary Bell
Chambers Trucking Ltd.
Dave Forster
Tom Northcote
Alan Ferguson

APPENDIX 6: GLOSSARY

Absorb - To take in or to combine or to merge into itself.

Acute Toxicity - A relatively short-term lethal or sublethal effect, usually defined as occurring within four days for fish and macroinvertebrates and shorter times for smaller organisms.

Adsorb - to hold molecules of a gas or liquid to the surface of a solid material.

Adsorbable Organic Halogens (AOX) - Halogens contained in organic compounds which are separated by adsorption on activated charcoal for subsequent halogen measurement expressed as $\mu g\ Cl_2$ per litre of solution. In kraft pulp mills, chlorine is the only halogen used in measurable quantities, so that the concentration of AOX in a liquid is a good estimate of the concentration of all chlorinated organic compounds in that liquid. See also TOC1. The measurement of the concentration of chlorinated organic compounds in a sample determined by the AOX method is usually greater than by the TOCl method because more compounds stick to charcoal than to ion-exchange resin.

Air-Dried Tonne (ADt) - One of two levels to which pulp may be dried. The term "Air Dry" signifies 90% dry fibre and 10% moisture (1 ADt = 900 kg Oven-dried pulp).

Algae - A group of aquatic plants, variously one-celled, colonial or filamentous, containing chlorophyll and/or other pigments and having no vascular system or true roots.

Allowable Annual Cut (AAC) - Annual harvest of trees in a managed area set by the Chief Forester of the Province.

Anaerobic - Refers to a condition or to organisms where there is a complete lack of oxygen.

Attached Algae - Algae growing on any fixed surface such as stones on a stream or river bed.

Bed Load - The amount of material transported down a river or stream bottom (bed) that does not leave the bottom to be carried in suspended load.

Benthic - Referring to the bottom of streams, lakes or oceans.

Benthos - Organisms dwelling on or in the bottom of rivers, streams or lakes.

Best Available Control Technology (BACT) - Currently available, state-of-the-art control technology which is proven and has been successfully applied for at least one year in similar facilities and which is reasonably cost effective as determined by regulatory agencies.

Bioaccumulation - The uptake and storage in tissues of an aquatic organism of a chemical from the diet and/or the surrounding water.

Bioassay - The use of an organism or part of an organism as a method for measuring or assessing the presence or biological effect of one or more substances, wastes or environmental factors under defined conditions.

Bioavailability - The availability for uptake, by whatever means, of a material to organisms in a food chain or web.

Biochemical Oxygen Demand (BOD) - The amount of oxygen needed by microorganisms to decompose substances dissolved or suspended in water. BOD is a property of water or wastewater, determined by measuring the quantity of oxygen consumed by a sample under controlled conditions (20°C, pH7), for a defined period, after 5 days, hence BOD_5.

Bioconcentration - The accumulation in an aquatic organism of a chemical taken up directly from the water.

Biofilms - Thin-layered films formed by bacteria, fungi, or other organisms which may take up and/or accumulate contaminants.

Biomagnification - The accumulation in an aquatic organism of a chemical taken up through diet (via the food chain).

Biomass - the total weight of a species or group of organisms in a particular area.

Biosolids - Fine particles (mainly microscopic) of organic solids originating largely from partially decomposed bacterial cells and wastes.

Biota - All the various species of organisms living in an area.

Bio-treated Effluent - Effluent which has received some treatment and breakdown by organisms, normally bacteria.

Black Liquor - The chemical solution produced in the digester of a pulp mill after the reaction of wood and white liquor. It contains organic material dissolved from the wood and inorganic chemicals from the white liquor.

Carbon Dioxide (CO_2) - A heavy colourless gas that is formed by the combustion and decomposition of organic compounds and is absorbed by plants during photosynthesis to form the skeleton of plant sugars.

Carbon Monoxide (CO) - A colourless and odourless very toxic gas that is formed by the incomplete combustion of carbon. It reacts with oxygen to form CO_2.

Chemical Oxygen Demand (COD) - A measure of the oxygen equivalent of the organic matter that can be oxidized by a strong chemical oxidizing agent in an acidic medium; provides an indication of the content of organic matter in wastewater and natural waters.

Chlorinated Hydrocarbons - (See also hydrocarbons). Hydrocarbons with one or more chlorine atoms attached onto the molecule. May be a byproduct of the chlorine bleaching of pulp, or the result of microbial action.

Chlorinated Organic Compounds - Compounds that contain carbon and hydrogen (i.e. organic chemicals), with attached chlorine. See AOX.

Chlorinated Phenols - Phenols with one or more chlorines attached to a benzene ring.

Chlorine (Cl) - A halogen element that is isolated as a heavy greenish yellow gas with a pungent odour. It s used as a bleach, oxidizing agent, and disinfectant in water purification.

Chronic Toxicity - Long-term effects that may be related to changes in growth, metabolism, reproduction, disease resistance and death. Often signifies effects occurring over periods of at least one tenth of the life span of the organism.

Clarifier - Tanks in which suspended solids are allowed to settle for removal from mill waste water.

Conductivity - A measure of the ability of water to conduct an electric current, measured across a 1 centimeter distance and standardized usually to a temperature of 25°C.

Cumulative Effect - An effect which gradually intensifies by accumulation of its causal agent.

Daphnia - A freshwater micro-crustacean found in ponds, lakes or streams. Sometimes referred to as water fleas. Genus *Daphnia.*

Degradation - Breakdown of a compound into smaller molecular-sized parts.

Deposition - The accumulation of materials on the bottom of a river or lake by gradual settling.

Desorption - To expel or remove a substance, usually gaseous from the surface of adsorbing material.

Dioxins - A group of 75 different chlorinated derivatives of dibenzo-p-dioxin. There are no known industrial applications for these compounds. The most toxic dioxin is 2, 3, 7, 8-Tetrachlorodibenzo-dioxin (2378 TCDD).

Ecosystem - All the organisms and their environment in a basic functional unit of ecology.

Effluent - A waste material discharged into the environment. In this report, the effluent refers to the liquid waste of the pulp mill, together with its suspended materials, which is discharged into the receiving waters.

Extractable Organohalides (EOX) - A measure of the concentration of halogens in organic extracts of sediment or tissue samples; detects mostly low molecular weight compounds, such as chlorinated phenolics.

Food Chain - The succession of levels through which energy (and contaminants) pass from individuals at one level which are consumed by those at the next; e.g. attached algae are eaten by a snail which is eaten by a bottom feeding fish which is eaten by a fish-eating fish which is eaten by a human.

Food Web - All the combined food chains, often with multiple interconnections, that occur in an ecosystem.

Forest Tenure - Various rights to harvest timber from Crown lands granted by the Ministry of Forests, including Timber Supply Areas (TSAs), Tree Farm Licenses (TFLs), and Pulpwood Agreements (PAs).

Foul Condensate - A recovery process condensate of foul odour.

Furans - A group of 135 chlorinated derivatives dibenzofurans. The most common furan in pulp mill effluents is 2, 3, 7, 8 - tetrachlorodibenzofuran (2378-TCDF). A furan contains one oxygen molecule less than does a dioxin.

Grab Samples - Samples taken manually by dipping from a container or vat in a mill or from a river or lake surface.

Guaiacol - Refer to Figure 13.

Haematocrit - Packed volume, following centrifugation, of circulating blood cells; expressed as a percentage of the whole blood volume. Values correspond primarily to erythrocyte (red blood cell) content.

Halogens - A group of elements of which the common ones are chlorine, fluorine, bromine and iodine.

Hog Fuel - Term for wood waste fuel widely used in pulp and paper industry boilers. It includes a mixture of any of the following: bark, sawdust, reject chips, sticks, branches, cutoffs, and other saw mill and wood harvesting wastes. The major component is usually bark.

Hydrocarbons - Compounds composed primarily of hydrogen and carbon, with either straight-chain, or cyclic molecular structure. They are constituents of our pollution (as a result of the burning of fossil fuels) or water pollution (contributed to by crude oil).

Hydrophobic - describes a material or compound which avoids or resists contact or dilution in water.

Hydrophylic - Describes a material or compound which "seeks" contact with waster or easily becomes dissolved in it.

Infrastructure - Servicing required to support development, including roads, water, sewer and power.

Initial Dilution Zone (IDZ) - An area where the provincial water quality objectives do not apply and which, by definition, extends 100m down-river from a riverine effluent discharge and not more than 50% across the river width.

Interstitial Water - Water lying within the river bottom between the particles (mud, sand, gravel, etc.) which make up its bed.

Key Indicators - Species or small groups of organisms selected as being good indicators of certain environmental conditions, such as pollution or the level of it.

Kraft Pulp - Pulp produced by a chemical process using cooking liquor containing sodium hydroxide and sodium sulphide.

LC_{50} - The concentration of a pollutant that results in death of 50% of the test organisms over a specified period of time, often 96 hours; hence the 96 hour LC_{50} acute toxicity test.

Leachate - Water containing dissolved or suspended materials that has percolated through solids such as soils, solid wastes and rock layers.

Lignin - Naturally occurring phenolic polymer found between cell walls of woody tissues.

Loading - The total amount of a material introduced over a particular period of time, e.g. daily, monthly, annually.

Macroinvertebrates - The larger invertebrate animals (those without backbones formed by vertebrae)

Microtox - An automated rapid screening assay which determines the EC_{50} concentration of a chemical or effluent which reduces the amount of incident light emitted by a culture of fluorescent bacteria *(Photobacterium phosphoreum).*

Mutagenic - Ability to induce genetic mutations.

Nitrate - A salt of nitric acid. Sodium nitrate and potassium nitrate are used as fertilizer.

Nitrogen (N) - An odourless, tasteless gas that comprises approximately 78% of the volume of the atmosphere, the element (N) occurs as a constituent in living tissues in combined form.

Non-Condensible Gases (NCG) - Non-condensible gases are gases emitted from several parts of the kraft pulping process which do not condense in the condensing equipment.

Non-Point Source - Type of contamination in which pollutants are discharged over a widespread area or from a number of small inputs rather than from distinct identifiable sources, as in storm run-off from agricultural regions.

Oven-Dry (OD) - Pulp or paper dried in an oven by a standard laboratory procedure to the point where it contains no moisture.

Particulates - Minute separate particles found in air or water, e.g. smoke or detritus.

Periphyton - Attached freshwater or marine algae; mainly filamentous.

Peroxide Bleaching - A bleaching stage using hydrogen peroxide. The bleach liquor contains hydrogen peroxide, sodium silicate, sodium hydroxide and magnesium sulphate.

Phenols, Phenolics, Chlorophenols - Refer to Figure 13.

pH - A symbol for the degree of acidity or alkalinity of a solution; originally expressed as the logarithm of the reciprocal of the hydrogen ion concentration in gram equivalents per litre of solution. A neutral solution has a pH of 7.

Phosphorus - This element plays a major role in biological metabolism. Compared to the other macronutrients required by biota (e.g. carbon and nitrogen), phosphorous is least abundant and is the first element to limit productivity of algae in freshwater aquatic systems.

Physiological Change, Response - A change or response affecting some bodily functions such as locomotion and respiration.

Plume - The main pathway for dispersal of effluent within the receiving waters, or emissions to air, prior to its complete mixing.

Polychlorinated Biphenyls (PCB) - Any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine. These chemicals have various industrial uses and are poisonous environmental pollutants which tend to accumulate in animal tissues.

Ppq - Parts per quadrillion.

Ppt - Parts per trillion.

Primary Treatment - An initial stage of waste treatment intended to remove suspended solids from the effluent, normally includes removing water from the recovered settled solids or sludge (dewatering) to facilitate disposal to landfill or the combustion process.

Productivity - The rate at which biological material is elaborated, usually on a weight per unit time basis, e.g. grams per day.

Resin Acids - Constituent acids of pitch, a solid or semi-solid plant exudate. The toxicity of pulp mill effluent is often attributed to the resin acids and other chemicals.

Round Wood - Logs suitable for making pulp.

Sawmill Chips - Chips remaining from the sawing of lumber, sold as byproducts by sawmills.

Secondary Treatment - A stage of waste treatment in which microorganisms (bacteria) decompose organic constituents in the effluent. In the process, they use oxygen for their metabolism and to oxidize the waste material. Most secondary treatment processes also reduce toxicity and reduce the dissolved organic load of the waste streams.

Sorption - the processes of absorption and adsorption.

Slag - Vitreous (glass-like in hardness) smelting-refuse.

Sludge - Thick deposit, greasy mud, sewage.

Sublethal - A concentration or level that would not directly cause death, but causes impairment in an organism, so that some other mortality agent, e.g. a predator, may act more effectively.

Supersaturated Gas - A gas in a solution at a concentration exceeding the amount expected if fully (100%) saturated at ambient temperature and pressure; may result from physical causes (e.g. in a river below the plunge-pool of a waterfall or dam) or biological causes (e.g. during a period of intense algal growth).

Synergistic Effect - An effect whose action is increased (sometimes decreased) as a result of other conditions (e.g. a certain level of pollutant may have a more lethal effect than expected when unfavourable conditions such as low oxygen concentration or low pH prevail).

Tailrace - The concrete chute at the downstream face of a dam through which released water pours.

Tertiary Treatment - A final process of effluent treatment which may be used after primary and secondary treatment steps. It includes a broad range of processes used to remove any of chemicals, colour, odour, taste and toxicity from the effluent before discharge. It is often used for removing nutrients, in solution especially phosphorus, from municipal effluents.

Total Organic Carbon (TOC) - A measure of the total amount of organic matter present in a liquid sample. A known amount of sample is injected into a high temperature furnace and oxidized to CO_2 in the presence of a catalyst. The CO_2 produced is then measured.

Total Organically Bound Chlorine (TOCl) - The quantity of organically bound chlorine in a sample. This method is similar to the measurement of AOX, except that the TOCl is sorbed onto XAD (ion-exchange resin), instead of activated carbon. This is a measure of the total chlorine in organic compounds, many of which may be unidentified.

Total Reduced Sulphur (TRS) - The sum of the sulphur compounds hydrogen sulphide, methyl mercaptan, dimethyl sulphide and dimethyl disulphide that are released during the kraft pulping operation.

Total Suspended Solids (TSS) - A measure of the total amount of organic and inorganic, living and non-living particulate matter suspended in a water or wastewater.

Toxic - A substance, an exposure or a concentration, that is harmful to a living organism.

Toxicity Equivalents (TEQ) - Used to compare the concentrations of other chlorinated dioxins and furans to 2378 TCDD. The concentration of a compound is multiplied by its toxicity equivalents factor (TEQ) to give its toxicity equivalents concentration (TEC). The TECs for all dioxins and furans in a sample are summed to give the 2378 TCDD TEQ.

Volatile Organic Compounds (VOC) - Any organic compound that can be gaseous at room temperature.

Volatilization - The evaporation of a liquid into a gaseous phase.

Woodroom - The area in a pulp mill where whole logs are ground up into chips, usually with some loss of bark and other debris.